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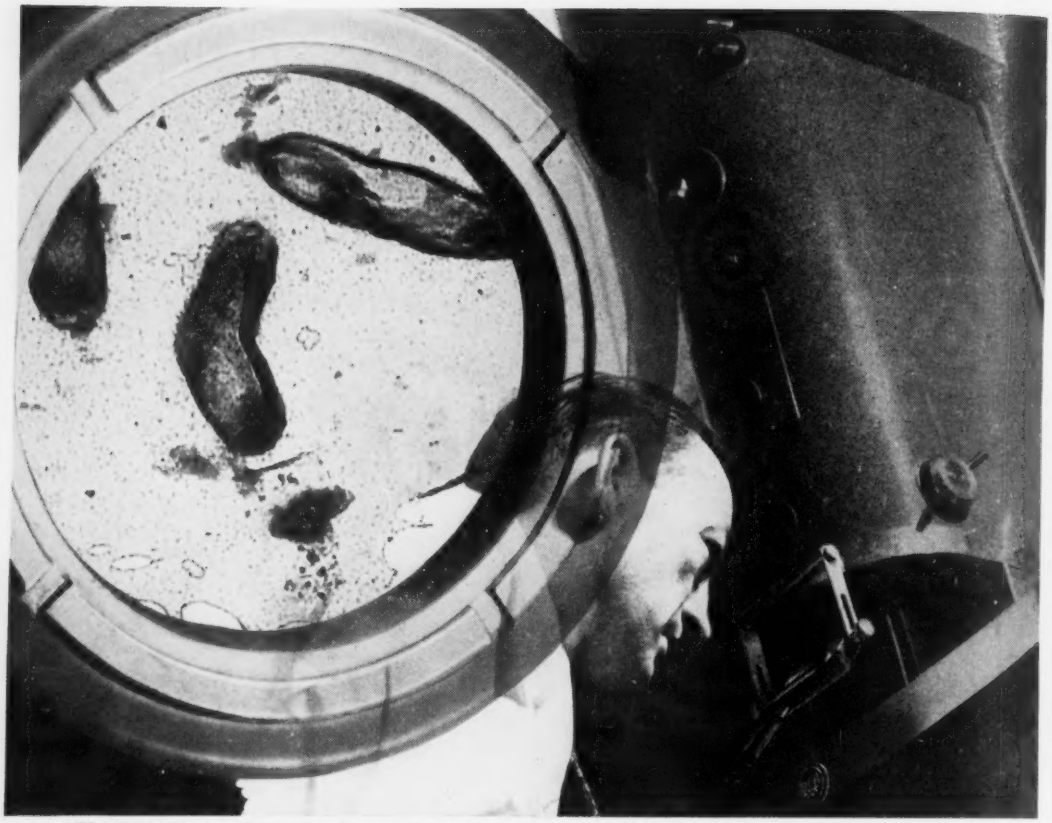

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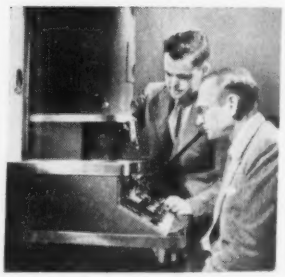

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THE SCIENTIFIC MONTHLY

NOVEMBER 1946

THE SMITHSONIAN IN A WORLD AT WAR

By C. G. ABBOT

RESEARCH ASSOCIATE, SMITHSONIAN INSTITUTION

In Oliver Wendell Holmes's famous poem "The Deacon's Masterpiece: or the Wonderful 'One-Hoss Shay'" we read:

> Little of all we value here
> Wakes on the morn of its hundredth year
> Without both looking and feeling queer.

The Smithsonian Institution at its century mark finds itself in a world filled with strife. Groups, parties, governments, and individuals seem to have gone over to the view that only by selfishly fighting can they hold their places in the sun or better themselves. If they better themselves, it must be by others' loss.

This is so contrary to the faith and policy of the Smithsonian Institution, both at its foundation and throughout its century of being, that the Institution, as Dr. Holmes says, is in the way of "looking and feeling queer," almost out of place and incongruous, indeed, in such a world as now surrounds it.

Its founder, James Smithson, gave only the simplest of conditions with his gift. It was "to found at Washington an establishment for the increase and diffusion of knowledge among men." He believed that increase and diffusion of knowledge is a boon and he desired it for all men. There are those in our time who suggest that increase and diffusion of knowledge is an evil, because it gives evil men greater capacity to do harm. But we have only to take the long view, looking back to the Stone Ages, to see plainly the contrary. Knowledge extends and saves life, fills it with comforts, and removes fears of old bogeys.

What a statesman James Smithson was! He gave his fortune to a young and vigorous nation, untrammeled by the conventions of long-established institutions. He attached no hampering conditions, trusting in the wisdom and good will of those who would administer the gift in all future time. One needs only to compare this policy with what happened to the bequests of Benjamin Franklin to see the wisdom of Smithson.

Benjamin Franklin, dying in 1790, bequeathed £1,000 each to the cities of Philadelphia and Boston; his bequest was hedged about laboriously with conditions. The gifts were to be administered by trustees of special types—particularly described by Franklin—for the purpose of making loans to "young married artificers." Applicants must have served apprenticeship in either Philadelphia or Boston and be certified as of "good moral character" by at least two responsible citizens, willing to be sureties for the repayment of the loan at 5 percent or more. Not more than £60 or less than £30 was to be loaned at a time and one-tenth was to be repaid with interest each year. Franklin went on to compute the values of the trusts at the ends of one and of two centuries and specified that after one century £100,000 of each

fund should be devoted to public improvements, "as fortifications," and the balance to be employed as before during the second century.

The upshot was that the terms of the bequests could not long be carried out, and both were adjudicated by the courts. Neither bequest received anything like the accretions Franklin computed, and both were assigned by the courts to other objects than those he proposed.

Not only did James Smithson give a statesmanlike and altruistic example, but the policy laid down by Joseph Henry, the great first Secretary, carried the Institution forward in the same unselfish line. He held that the wording "increase and diffusion of knowledge among men" was deliberately and intelligently employed. No local or even national interests limited the scope. Knowledge was to be promoted by original research, and it was to be diffused as widely as possible to all mankind. If projects undertaken by the Institution were adopted and adequately continued by others, the Institution should withdraw and devote its means to other, more needy, projects.

Such were Secretary Henry's wise and altruistic policies. They have continued to be the Institution's policies for a hundred years. But now we see more and more governments, unions, and groups concentrated under the control of supermen. The rank and file receive their orders from central authorities and for the most part follow blindly. In short, the social methods of the ants and bees seem to be more and more recommended and followed throughout mankind.

This practice is the antithesis of the views of the Founding Fathers and of Smithson. They wished to promote knowledge and wisdom among all the people, so that all should take helpful and intelligent parts in public affairs. Ants and bees, indeed, provide for food and shelter and defend their domain from assault. This they have done for thousands of years, neither better nor worse now than formerly. But man, by the increase and diffusion of knowledge, has advanced at the same time from beastly barbarism to civilized culture.

The ideal we follow, of self-government by enlightened people of good will and steadily growing knowledge and wisdom, is perfectly attuned to the principles and practice of the Smithsonian Institution. The adoption of forms of government incompatible with good will and subversive of the universal diffusion of knowledge leads backward toward the Dark Ages and beyond.

There are two methods of protecting the individual. Among beasts and vegetation, and largely among men, the individual fights for his own advantage. This is the primitive method. The other must await the growth of the mind and of altruism. Confucius, some 2,500 years ago, said negatively in these express words: "What you do not like when done to yourself, do not do to others." Jesus Christ, about 500 years later, stated it in the positive sense: "As you would that men should do to you, do ye also to them likewise." If these precepts were universally followed, and wisdom as well as altruism were diligently sought, all individuals would be cared for, since everyone would intelligently seek the interest of every other. And this would be a world of love and not of hate.

It has been a long time since these precepts were promulgated. They are too little heeded. But in an atomic age, if the world continues to practice the primitive method of the survival only of the strongest and the overawing of the weak, will not civilization fade away?

SCIENCE IN UNESCO

By BART J. BOK
HARVARD COLLEGE OBSERVATORY

Since wars begin in the minds of men, it is in the minds of men that the defenses of peace must be constructed.

AT THE height of the war, about two and a half years before the United Nations Organization was created at San Francisco, a group of allied ministers of education held a series of conferences on postwar problems of international cultural collaboration. These conferences, held in London in the fall of 1942, mark the beginning of the United Nations Educational, Scientific and Cultural Organization (UNESCO). At first the participants to the conferences were only representatives of Great Britain and a group of ministers of education of governments-in-exile, but early in 1943 this group was enlarged to include delegates or observers from the United States, the Soviet Union, China, the British Dominions, and India.

By April 1945, at the time of the San Francisco Conference, the need for an educational, scientific, and cultural organization directly under the United Nations was realized by many groups, governmental as well as others. In the United States our State Department was taking an active interest in the proposals and, following the San Francisco Conference, Under-Secretary of State Archibald MacLeish was one of the most active participants in the planning for an effective organization under the United Nations. Private individuals and organizations gave their support to the plans. The American Association for an International Office of Education, with James Marshall and Harlow Shapley as the principal spark plugs, worked consistently for a strong organization and for effective participation by the United States. The American Association of Scientific Workers submitted a number of proposals for the activities of the scientific division of the international organization.

Congress showed an early awareness of the need for an international organization of a cultural nature. On May 22, 1945, the House of Representatives adopted the Mundt Resolution calling for an international organization, and two days later the Senate passed the comparable Taft-Fulbright Resolution. Both resolutions were carred unanimously.

THE Charter Conference of the United Nations Educational, Scientific and Cultural Organization was held in London in November 1945. The London meeting, at which forty-three nations were represented, drafted a constitution for the newborn organization; the quotation at the head of the article is from the preamble to this constitution. The delegates of the various nations affixed their signatures to the UNESCO constitution and then returned home to request formal ratification by their governments. According to the constitution, UNESCO really came into existence following ratification by twenty of the nations represented at the Charter Conference. To carry on the organizational work and planning for UNESCO, there was established in London a UNESCO Preparatory Commission, of which Dr. Julian Huxley, the well-known British zoologist, is the Executive Secretary.

Since UNESCO will deal with the whole field of international relations in

education, science, and culture, several divisions were created under the Preparatory Commission, one of them a Natural Sciences Division. It was indeed appropriate to have Dr. Joseph Needham head of this division, for Needham is the man who did as much as anyone to put the *S* into UNESCO. When in 1944–1945 the first plans were under discussion, there were several powerful groups in our own country and abroad that attempted to limit the activities wholly to the educational and cultural aspects of international relations. Scientists in the United States, France, China, and Britain rose in protest against a lopsided UNECO (without an *S*); it was Needham, as a spokesman for the British scientists, who first urged the change of name from UNECO to UNESCO.

In November of this year UNESCO will hold its first full-fledged conference at Paris. The Preparatory Commission will then present for consideration the initial program for UNESCO and at the conclusion of the Paris Conference the new organization will begin actual operations, with its headquarters in Paris.

Our State Department, assisted by the various groups interested in UNESCO, has taken an active part in the work of the Preparatory Commission. Mr. Charles A. Thomson, of the State Department, has been the coordinator of most of these activities. To aid in the planning for the Natural Sciences Division, the Secretary of State appointed a Scientific Advisory Group, with Dr. Detlev Bronk, representing the National Academy of Sciences and the National Research Council, as chairman. The members were Charles E. Kellogg, Howard A. Meyerhoff, W. Albert Noyes, Jr., Stewart E. Reimal, Harlow Shapley, Merle Tuve, and Raymond L. Zwemer; Rollin Atwood was the Executive Secretary of the Group. The Scientific Advisory Group acted as a clearing house for suggestions and collaborated closely with the Preparatory Commission in London.

A bill for the ratification of UNESCO was passed without difficulties or delays by both Houses, and the United States formally joined UNESCO on July 30, 1946, when President Truman signed the bill. The bill calls for the creation of a National Commission on Educational, Scientific and Cultural Cooperation with a total membership not to exceed one hundred. A maximum of sixty representatives may be appointed by the principal national organizations interested in matters related to UNESCO. The Secretary of State is authorized to select the remaining forty members.

On September 18, 1946, Assistant Secretary of State William Benton announced the composition of the first U. S. National Commission for UNESCO. It is disappointing to find that six of the seven scientists of the Scientific Advisory Group were not invited to join the National Commission. The five natural scientists among the ninety members of the National Commission are Arthur H. Compton (member-at-large), Detlev Bronk (for the National Research Council), James B. Conant (for the A.A.A.S.), Reuben Gustavson (representing State and Local Government) and Ross G. Harrison (for the National Academy). Although it has been generally accepted that the natural sciences should be responsible for at least one-sixth of the activities of UNESCO, they are given about one-twentieth of the job by the State Department.

NEITHER our State Department nor the UNESCO Preparatory Commission has issued public reports about the program of activities for UNESCO to be submitted to the Paris Conference in November. Out of the welter of sug-

gestions made so far, the general program for at least the Science Division begins, however, to emerge. It is a preliminary and highly flexible outline of a program, and anyone who attempts to assign tentative priorities does so in the realization that the order and emphasis are bound to be changed when the democratic process starts operating in full at the forthcoming Paris Conference. It is, however, high time for American scientists to give more than casual thought to the program for UNESCO. At the November Conference in Paris definite plans will be made; the time to make one's voice heard is now.

It would lead too far afield to examine the outline for the full program of UNESCO, and we shall therefore limit ourselves here to an examination of some suggestions for activities of the Science Division.

When planning for UNESCO, a scientist must keep in mind that the "construction of the defenses of peace" is the primary aim of the new organization. Science comes to UNESCO to make a contribution to world peace and international understanding and *not* to feed surreptitiously from an international trough. If, by accident, UNESCO should be able to serve the advance of science, so much the better, but we should not outline its program with that as our primary aim.

The UNESCO planners are facing the difficult task of building a program which blends effectively long-range schemes of obvious importance for international relations and short-range projects that can serve to dramatize promptly the potentialities of international collaboration. Under the present precarious conditions for world peace, a limited project that begins to pay dividends right away may be more valuable than an extensive one of which the full benefits will not be realized until five or ten years hence.

Most proposals for UNESCO activities that I have seen agree that exchanges of scientists, young and old, should rate top priority. Unless scientists are given the opportunity to travel, science will become institutionalized and provincial in outlook. Young research scientists and students need to travel to get a broader outlook on their prospective fields of investigation. Older men and women want the stimulation that comes from contacts with friends and colleagues from other countries. Scientists from backward nations, young and old alike, will need periods of study at the great research centers of the world. In turn, the backward nations will require for their development visits of varying duration from scientists of countries where favorable conditions for research exist.

UNESCO is in a position to promote exchanges in a variety of ways. The establishment of a number of UNESCO fellowships appears almost certain. What could be better propaganda for internationalism than two or three hundred UNESCO Traveling Fellows? The American Chemical Society has already offered ten graduate fellowships of this nature. Fellowships are relatively easy to administer, and not much time is required for the selection of capable and internationally-minded scientists. In the discussions of the past few months it has been stressed that exchanges should be arranged at all levels. Students, technicians, teachers, research men, from the little fellow to the Academician, all have their special contribution to make to world peace and international good will. Shapley has made the suggestion that UNESCO could well sponsor "Traveling Panels," composed of experts (no two of them of the same nationality) traveling as a group from one local cultural center to another, staying at each center for not more than one or two weeks. The members of the UNESCO Panels

would be available not only for technical conferences and seminars, but also for illustrated lectures to the general public.

Frequently UNESCO will act only as a coordinating agency and may request a government or a research foundation to award certain fellowships. In some cases UNESCO may do no more than provide suitable letters of introduction, and there has been some talk of "UNESCO passports" for bona fide traveling scientists.

UNESCO should include engineers in its system of exchanges. A suggestion which has appealed to me is that of truly international technical commissions with the UNESCO label. If the government of China, for example, wishes the aid of a technical commission to advise on a flood-control project, there is much to be said for a UNESCO commission with representatives from several nations, as opposed to the customary type of advisory commission set up by a single government.

One of the principal points of argument at the London Conference of November 1945 was about the role which UNESCO should play in connection with the rehabilitation of scientific institutions in devastated countries. After long debate it was decided that UNESCO should survey the existing needs and make recommendations for reconstruction measures, but that the actual execution of the rehabilitation program should be in the hands of other UN organizations or of national governments. The Preparatory Commission and our National Commission are both aware of the urgency of scientific rehabilitation. With UNRRA gradually winding up its affairs, the responsibility for presenting a comprehensive program becomes that of UNESCO. The Preparatory Commission has argued that the task of scientific rehabilitation should be largely entrusted to the Natural Sciences Division. Our National Commission is pointing out that special appropriations will be needed if UNESCO is to undertake the work.

In the field of abstracting, UNESCO will probably be the organization to make comprehensive surveys of the needs. It will be in keeping with its status as a coordinating agency not to interfere with existing abstracting organs but to encourage their work. Wherever a serious gap is found to exist, UNESCO should take whatever steps appear to be necessary, but only in case no other solution is in sight should UNESCO itself become involved in the setting up of an abstracting service.

In the end UNESCO will probably work for some sort of unification in scientific abstracting. It is clearly within the mandate of UNESCO to facilitate in every way possible the prompt interchange of information. Within a few weeks after publication, reports of research published in any one country should be available everywhere in the world, at least in English and French and preferably also in Russian.

An important phase of UNESCO's work will be in the field of science education of the masses. Movies, radio, and microfilm will all play their part in this work. Some sort of international science news service will have to be established under UNESCO. It is clearly the function of UNESCO to inform the public everywhere on the bearing of scientific discoveries on international relations.

The Preparatory Commission for UNESCO is laying the foundation for effective collaboration with other international agencies, the UN Atomic Energy Commission, for example. Preliminary discussions with representatives of the UN Food and Agriculture Organization, of the International Health

Organization, and of UNRRA indicate that the Natural Sciences Division of UNESCO will probably become the central scientific coordinating agency in the United Nations Organization.

One of the expressed aims of UNESCO is to do everything possible to support the work of the International Council of Scientific Unions. UNESCO's support has been promised to those international unions that are entitled to it. Here again the function of UNESCO will not be to supplant existing organizations, but rather to facilitate and assist those which show the greatest promise of being of service to the cause of good international relations. In the prewar years the young Committee on Science and its Social Relations was one of the most hopeful developments under the International Council of Scientific Unions. With the joint support of the International Council of Scientific Unions and of UNESCO, this Committee may become an integral part of the Economic and Social Council.

THE planners for UNESCO's scientific activities are all active scientists and not bureaucrats. They do not wish UNESCO to become a top-heavy bureaucratic organization. There will be a central office in Paris, but this should in no way dominate the activities of the world-wide organization. Following an original suggestion by Needham, there are plans afoot to set up a series of regional science cooperation offices. Where the Unions represent the various sciences on a world-wide basis, the regional UNESCO offices will cover all sciences, but they will serve primarily the regions where they are located. The Unions are now strongest in the centers of intensive, advanced scientific activity, but some regional offices can also be established in scientifically backward areas. In recommending the setting up of these offices, the Preparatory Commission recognizes that one of UNESCO's principal functions is to spread the benefits of scientific advances wider than has hitherto been the case.

Exchanges, abstracting, collaboration, coordination are useful, but a program built on them alone will lack the drama needed to make UNESCO an effective agency for world peace. Various governments have suggested that UNESCO should foster some International Institutes carrying its name. There is, for example, much support for an International Center of Applied Mathematics, to be located somewhere in Asia, probably in India. There may be one or more International Nutritional Laboratories, an International Resources Office, an Equatorial Tropical Survey Institute, and others like them. The International Astronomical Union has requested that one or two "UNESCO Observatories" be established (preferably one in the Northern Hemisphere, the Mediterranean region; the other in the Southern Hemisphere, South America) with the most effective modern telescopes and accessories that can now be built. Such observatories would give the astronomers of, for example, Poland, Belgium, China, and Uruguay opportunities for observational research equal to those of their colleagues in the United States. In turn the credit for the discoveries made at the UNESCO Observatory would go not only to the nation to which the individual discoverer happens to belong, but also to UNESCO and the cause of international collaboration. The UNESCO Observatory on its mountain-top may well become the symbol for internationalism.

IT HAS been unfortunate that up to this point the Soviet Union has not participated in the preliminary work of UNESCO. The reason given for the Soviet refusal has been that the Soviet Union cannot collaborate until UNESCO

has become formally a member organization of the United Nations. Informal assurances have, however, been received that the Soviet Union will join UNESCO soon after the new organization becomes a permanent UN agency. The supporters of UNESCO are without exception eager to see the Soviet Union in the new organization. Without USSR participation UNESCO will be unable to fulfill its truly international functions. UNESCO can do no greater service to world peace than through the development of certain scientific exchanges between the Western nations and the Soviet Union.

WHAT can we scientists as individuals do to promote UNESCO? First, we must all acquire the habit of thinking hard about UNESCO and its function in the international order. Second, when we arrive at conclusions or have suggestions about the program for UNESCO, we should make these known to the National Commission, either individually or through our organizations. Third, since November 1946 is to be the "UNESCO month" and since the third week of November of this year will be "UNESCO week," we should in our communities arrange at that time for lectures, exhibits, and conferences on UNESCO and its role in world affairs. Fourth, when early in 1947 UNESCO's program gets really under way, American scientists should do all they can to make it a success.

UNESCO can and will succeed if it has the united support of all men and women of good will. Fortunately they are still in the majority in the world of today.

BART J. BOK AND UNESCO

Explaining his interest in UNESCO, Professor Bok writes: "My interest in UNESCO is one phase of a lifelong interest in international relations in science. I met many of my friends of today (including my wife, Priscilla Fairfield Bok, who is the co-author of our book on *The Milky Way*) for the first time at a meeting of the International Astronomical Union at Leiden in 1928, when I was an astronomical student in Holland. I received most of my training in Holland at the Kapteyn Laboratory, the headquarters for the Plan of Selected Areas, an international enterprise for the study of the structure of the Milky Way System.

In recent years I have been the chairman of the American Astronomical Society's wartime Committee on the Distribution of Astronomical Literature and I have been to Mexico three times, as the guest of the Mexican government, to help in planning for the Observatorio Astrofisico Nacional de Tonanzintla.

For some time I have been chairman of the International Relations Committee of the American Association of Scientific Workers. For the past year and a half this committee has worked on the program for UNESCO and as chairman of the Committee it has been my privilege to speak out privately and publicly on the subject."

BIOLOGICAL COLLECTING DURING WORLD WAR II*

By EGBERT H. WALKER
ASSOCIATE CURATOR, U. S. NATIONAL HERBARIUM

IT HAS been said that life in the Army and Navy, even in wartime, consists largely of long, boring waits interspersed with occasional violent activity. In order to offset the morale-killing effects of those long inactive hours, many scientists back home urged and assisted hundreds of servicemen during the war to take advantage of their idle hours and their interest in their new surroundings. They were asked to collect and send home specimens of the plants and animals they found about them. These would be added to the permanent research and study collections in museums and schools, thus enabling the servicemen pleasantly to turn waste time into solid accomplishment.

That this was no idle vision on the part of the scientists, many servicemen's letters bear witness. For example, Lieutenant D. C. Olsen, of the U. S. Army, a forester in civilian life, wrote: "I regret that I wasn't aware of your desire for specimens during the year and a half of cruiser duty I have recently completed. I had many opportunities to collect specimens in New Caledonia, New Hebrides, the Solomons, and the Admiralties." One man, a former botany student, suddenly discovered, when he was asked to collect plants, that even Army life could be interesting and soon wrote that he and his wife were determined to return to New Guinea after the war to resume collecting where he left off when transferred to the Philippines. He has now returned to his graduate botanical studies with a new purpose and enthusiasm. Many men were intensely interested in the natural life around them. Lieutenant W. H. Wagner, in the Naval Air Transport service, wrote:

> On any clear day a number of servicemen could be seen on the reefs bordering Kwajalein Island turning over rocks and watching small tidal pools to catch sight of the tropical marine fauna, including such diverse animals as sea-

* A scene on Okinawa, drawn by Captain L. T. Burcham, is shown above the title. The trees are probably the riu kiu pine (*Pinus luchēnsis* Mayr). The only specimens of this plant in the U. S. National Herbarium were presented by servicemen.

cucumbers, moray eels, slate-pencil urchins, hermit crabs, and brilliantly marked reef fish.

The number of people and institutions encouraging and assisting these men is unknown, but it is considerable. It includes parents, wives, friends, former professional associates and teachers from high school up, natural-science professors, museum workers, professional associations, especially the Society of American Foresters, and fellow-servicemen and officers. Professor H. H. Bartlett, head of the Department of Botany of the University of Michigan, developed an informal interinstitutional cooperative program aimed to coordinate the scattered interest and to provide more facilities for identifying the material collected, thus encouraging the collectors. This group worked in part through the United States National Herbarium under the Smithsonian Institution, largely because of its advantages as a governmental organization and its potentialities as a clearinghouse for collections received, and because of its need, as one of the nation's public herbaria, of increased collections from all parts of the world. Helpful literature was provided[1] and hundreds of letters were written to servicemen, whose interests and potentialities were determined through numerous and varied channels.

The underlying motive of the promoters of this servicemen's collecting program was partly to enlarge existing scientific reference collections, taking advantage of the unprecedented dispersal of biologists throughout the world. Another motive was to assist the young scientists and potential scientists, diverted from their normal careers by necessary military service, to retain their interest in natural science. Thus the failure to provide for the future increased need for scientific personnel through draft deferment would be at least in part offset. Also, scientists at home were being deluged with requests from servicemen for help in identifying the plants and animals around them and for books on the trees, orchids, fishes, birds, and other organisms. Ensigns Leupold and Ruth, graduate foresters, wrote from the Pacific, "The vegetation on this island is varied and very interesting, but we lack means of identifying any of the trees and shrubs or annuals. We are making a collection of all the species of vegetation and preserving them by drying." What they and many others wanted was a "Gray's *Manual*" for the Southwest Pacific. As there were no such works in existence for the Pacific, the Aleutians, or the Far Eastern theatres, the men were urged to gather the materials from which the manuals of the future could be prepared.

How successful the serviceman's collecting program was in attaining its objective of increasing scientific collections and providing future biologists cannot be entirely determined. The 6,000 plant specimens received by the U. S. National Herbarium in 1945 are probably only a small part of the whole. How many men have been saved from lives of boredom and will become scientists, only time will tell, but there are enough budding and enthusiastic botanists and zoologists from this source now working for advanced degrees to give us much satisfaction. Their perspectives are wide, for they have been places and seen things that few American botanists have seen. We can only hope their teachers and advising professors can and are willing to maintain their broad interests so that they will extend the outlook of American botany and help this country to assume the leadership in world botany which now lies open to her. Professor Bartlett wrote one of them, "It is little short of scandalous that American scientists have done so little over so much of the world."

[1] E. H. Walker. "Natural History in the Armed Forces." THE SCIENTIFIC MONTHLY. 61, 307–312, 1945.

Germany has been the acknowledged leader in the world-wide aspects of natural science, botany especially. Will she remain so after World War II as after World War I? It seems unlikely, at least if this country has sufficient broad-visioned teachers and students.

The servicemen and women who participated in this collecting occupation were a varied lot, ranging from commanders to privates in all branches of the service. The majority seem to have been lieutenants, judging from my list of 38 collectors and over 166 correspondents. One excellent collection was turned in by a woman Red Cross welfare worker on Attu Island. Besides other collectors in the Aleutians and Alaska, there were avid workers in all parts of the Pacific theatre, including Australia, Burma, Assam, and India in the Far East, and a few localities in Europe. Some institutions have received specimens from Africa, South America, Greenland, and Iceland which were collected by members of the armed forces.

THE purposes of the men in taking up scientific collecting were many and sometimes novel. Most men were, like the ensigns just quoted, overwhelmed by the desire to learn about their surroundings through collecting. Some dyed-in-the-wool collectors, denied access to postage stamps, just could not help collecting. A misplaced gynecologist major in the medical service in the Aleutians, having little else to do in that womanless land, made a beautiful collection of plant specimens for the Chicago Natural History Museum that was worthy of public display. A zoologist wrote from Guam that boredom forced him to collect plants after exhausting his specialty, the snakes and other reptiles. A captain in Africa wrote for directions on how to collect insects, saying, "Unfortunately for our comfort we have what seems to be an unbounded supply of material, and I would like to make some use of them." Some had genuine urges to contribute to scientific progress, while others, though willing to help the cause, wanted first to assemble material for their future study for advanced degrees. A high staff officer, an ardent rock gardener, sought material in the Aleutians for his future peacetime back-yard avocation and gathered duplicate material for identification. Some collections were made in the line of duty by medical research men and those engaged in sanitary surveys.

Probably many specimens of potential scientific value were gathered with no such motives in view but rather just to startle and amuse the folks back home. Many will eventually drift into scientific collections. A navy lieutenant, fascinated by the gorgeous display of flowers in the Grampian Mountains in Australia, took kodachrome pictures and then wisely made pressed specimens for use in obtaining identifications. We heard of a colonel who relaxed by painting the orchids about his Burma headquarters, but we were unable to persuade him to press the specimens so they could enter the orchidologist's files while his paintings adorned the art galleries. A high naval officer in the Admiralties collected specimens to be identified for use in writing a full account of this little-known group of islands.

The specimens so gathered were usually limited in number and quality by the very unfavorable conditions under which the men worked. At least in the southwest Pacific area most collecting was done in the settled lowlands, for the ousted enemy made the hinterland unsafe. Private Ted Bayer, an amateur zoologist who packed his delicate crinoids from Biak Island in available lichens to prevent breakage and thus unintentionally also became a plant collector, wrote from the Philippines, "We usually keep to open country for obvious reasons. I have seen no mosses in most localities."

Thus much of the material collected represents a widespread and technically less interesting flora. However, even this was poorly represented in American collections, and these specimens of common species will doubtless often be referred to because of our increasing scientific and commercial interest in these distant and formerly little-visited shores.

Unfavorable collecting conditions and inadequate equipment discouraged many. Lieutenant W. G. Adams, a botany teacher in private life, wrote, "My collecting urge is with me out here in a field that is rich beyond imagination. During the past ten months I have collected many specimens only to have them mold." So far as known, he never succeeded in sending any material home. The high humidity was almost universal in the tropical and subtropical areas, and few were those men who succeeded in drying their plants over artificial heat, which is practically essential in those regions. However, enough did succeed to prove that it can be done with ingenuity and perseverance, even under the restrictions of Army and Navy life.

Many field officers were cooperative and encouraged their subordinates in their efforts to engage in more enduring pastimes than poker and baseball. One collection was received with a captain's validity certificate stating that it was not obtained by theft or loot. Another officer personally transmitted a private collection to avoid difficulties with postal authorities. A major, a trained forester, undertook to initiate an interested corporal in forestry through plant collecting, even though the corporal, a former cowboy, was as much at home in the jungles as a "cow on skates." Several collectors acquired close companions who, though never having previously heard of scientific collecting nor studied biology, have become ardent addicts and are now on their way to becoming professional, or at least high-grade amateur, biologists. Thus the enthusiasm spread.

Some officers, however, could not comprehend such values, frowned on this "unmanly" pursuit, and forbade the shipment of collections. More often, stifled ambition resulted from indifference and lack of knowledge of procedure rather than from outright opposition. Sometimes discouragement came from the long delay between the dispatch of collections and the receipt of reports from the scientists concerning them, a delay due not only to the slow mails but to inexperienced and overworked specialists. One specialist, Dr. E. D. Merrill, of Harvard University, took great care, however, to report determinations within 24 hours, his long familiarity with tropical flora and his commanding position in the botanical field making this possible.

Although statements were issued in 1944 by both the Army and the Navy notifying postal authorities that dried and pressed plants were specifically exempt from U. S. Department of Agriculture quarantine restrictions, few officials were aware of them and, in order to play safe, refused to accept packages of plant specimens. This was a hard blow to many ambitious collectors, who had labored hard only to be forced to discard their collections. A private in Greenland abandoned several bundles when transferred, and a colonel in the Pacific was unable to mail a specimen he wanted identified. Mimeographed copies of these regulations were eventually prepared and mailed to correspondents, although unfortunately rather late in the program. Pharmacist's Mate Knox, on receiving a copy, replied:

> I was most interested in the memo. It often helps to point to black-and-white instructions. With the aid of the serial number I was able to find the circular in the Navy Department Bulletin, but probably never would have otherwise, since there are two large volumes of them issued every year.

Organized encouragement of this activity existed in a few places in the services but has not been as widespread as it could be. It was my happy experience to find the Washington offices of the Army and Navy interested in scientific, educational, and welfare activities, especially the medical branches, willing and eager to cooperate with this program. The hugeness and the complexities of the Army and Navy organizations and the preoccupation of those in higher authority with more vital matters, however, too often stifled the good intentions of those in the lower ranks. Perhaps the welfare and educational organizations of the Army and Navy cannot include in their programs an avocation which will appeal to such a numerical minority as the biologists. This constructive and beneficial occupation might well be fostered, it seems to me, whenever it springs up naturally. The Army and Navy might take a lesson from the Guam Society of Natural Science, organized on that island by a few interested officers and men when conditions became relatively stable. The military government responded to requests for assistance by sending out announcements of meetings and cooperated in other encouraging ways. Weekly meetings were held in Agaña, lists of interested participants distributed, and scientific collecting stimulated. A wide range of talents was represented, and at one time up to a hundred persons attended the meetings. The Society also included some natives well informed on the island's plants and animals. With the permanence and stability a continuing welfare organization could give, the Guam Society of Natural Science could be of great value to many bored servicemen and to the institutions to which their collections may be sent.

One of the greatest difficulties of those at home who were interested in this source of material was in finding organized channels through which they could work. This is by no means all in the past, for our present army of occupation, consisting of many thousands of men scattered through the East, contains young biologists eager to respond to a little encouragement and guidance; and the need exists for organizing this resource for the benefit of the services and of science. Some slight interest has been shown by those engaged in educational work among the occupying troops, but so far as is known this educational opportunity has not been exploited. It is suspected that few of those engaged in such teaching are willing to expose their lack of knowledge of the organisms about them and have neither the time nor means to fill in the gap. Also, most of them, like their predecessors, have failed to comprehend the potentialities of scientific collecting and the need for more material.

Considering the vastness of the opportunity and the number of biologically-minded men and women in the service, the actual number of specimens gathered to date is somewhat disappointing. Few people know there is any need for scientific material or what constitutes a specimen or how to prepare it. It was surprising to one familiar with herbarium specimens to find that almost no one, not even college graduates in botany, had ever prepared a specimen and that many had never even seen them. The significance, use, and preparation of specimens is not taught in beginning courses in this country, although most European scientists learn this in the secondary schools. Many of the servicemen never even suspected that there were places where they could get information on the plants and animals about them. This, it seems to me, is most unfortunate, for specimen collecting and identifying is a means whereby those who have had beginning courses in botany and zoology can most readily continue their contacts

and education in these fields when they take up other pursuits. The elements of scientific collecting should be taught in beginning biology courses to give a continuing perspective and an opportunity for further biological contact to those who do not go on with more advanced work.

Lieutenant Wagner, writing of the wide interest in natural science says:

> Some of the hobbies of servicemen were of such potential scientific value it is regrettable that previous training had failed to equip them to turn spare-time efforts into scientific accomplishments. Thus in the Solomons a man made an enormous collection of Lepidoptera with intentions of studying the group. Unfortunately he kept no records and neglected the smaller, less brightly colored species which are often the rarest and least known. . . . These hobbies could provide much knowledge of the biota of little-known tropical lands.

It was a great disappointment that an ecologist with a Ph.D. degree failed to collect a single specimen on Guadalcanal, although he studied and photographed many plant formations in his spare time. A forester with the same degree said he had never made a plant specimen "because in New England the few forest trees are easily learned in field courses."

In spite of these shortcomings of servicemen's collections, many valuable specimens have been received. Because of the nature of taxonomic work, it is rarely possible to determine very soon after receipt of a collection what novelties or new species it contains, for it usually takes some years for a collection to be thoroughly studied by experts. Especially is this true for collections from the Southwestern and Western Pacific and the Far East. We know much more about the novelties in the servicemen's collections from the Aleutians, for, although no American botanists have as yet completed a manual of the flora of Alaska, they know much more about these plants and have been eager to study the collections from there. A new species of lupine has been described from a collection stuffed in a pack by E. D. McDonald while hunting for Japs on Kiska. Many new records of higher plants for Attu Island were made from servicemen's collections, and there will be many of mosses, liverworts, and lichens, which lowly plants have been previously little collected there. It is confidently expected that the studies of future years will reveal a rich harvest of new species, records, and valuable information of other kinds from these collections.

The value of the collections brought or sent back by these servicemen collectors will be partly lost by their being scattered throughout the country. Attempts are being made to list these collections, but many valuable finds will be stowed away and forgotten in attics at home or stored in some institution where they are neither properly appreciated nor adequately cared for. Specimens from Spanish-American war veterans and their descendants are still drifting into the larger museums, but often the accompanying data have been lost and the specimens thus rendered useless. Partly for this reason efforts were made in the servicemen's collecting program to encourage the sending of collections to the larger public institutions, from which duplicates and superfluous material will be distributed to others in this country.

Besides the hobby-inspired collections of servicemen, many thousands of specimens were collected by trained personnel engaged in special Army and Navy surveys. The specialists of Navy Medical Research Unit No. 2 collected thousands of plants and animals in Guam, helping to make the biota of that island now fairly well known, as well as solving some epidemiological problems. An entomologist in malaria control work on Okinawa made an extensive botanical as well as entomological collection. The United States of America Typhus Commission, in its search for the causes of the occur-

rence and spread of scrub typhus in Burma, made carefully documented collections of plants and of potential animal vectors. Full sets of these specimens are deposited in public institutions where they will be permanently available for reference. They have as yet for the most part been only superficially worked over and will continue to yield knowledge for years.

An unmeasurable by-product of this collecting were the many pleasant contacts between servicemen and local people with like interests. Major Lambert learned much about Philippine timber trees from native foresters and urged continued contact between them and interested American botanists. Private Jack R. McMillen, an ardent orchid hunter, with the U. S. Army in Burma, twice visited Dr. K. Biswas, the director of the Royal Botanic Garden near Calcutta, India, and sent or took most of his specimens there for identification and for subsequent division with the U. S. National Herbarium. Dr. Biswas wrote to me after this visit what a pleasure it was to meet an American botanist from the Army and expressed his hope that the officers would encourage their men to use this means of learning of their natural surroundings and of meeting the cultured Indians. The officers concerned with supplying food for the army of occupation in Japan through extensive hydroponic projects are working with Japanese botanists to mutual advantage.

THE personal experiences of the numerous biologists, as shown in their letters and notes, shed much light on the successes and failures of scientific collecting by men engaged in war. A few extracts from my files, in addition to the quotations already given, will reveal what a rich experience plant collecting has been.

Lieutenant Wagner, already quoted, writes in addition:

> You would be amused to see me hitchhiking on jeeps in advance areas, hiking up hill and down valleys looking for monitors, laughing jackasses (the kingfishers), geckos, and new sights in the world of nature. I have come across whole bodies while brushing through the woods on many hurried trips, but when you expect such things they don't jar you a bit. It is incongruous, though, to see evidence of such violence while engaged in the gentle and innocuous sport of botanizing. I have learned a lot about Pacific vegetation and have secured some fine specimens of Pacific rarities. My pteridophyte collection, made jointly with D. F. Grether [no biologist at all before he teamed up with Lieutenant Wagner] now totals over 700 collections. I am trying to get together a fern flora of Guam. Many species of pteridophytes have been reported from Guam by various authors since 1902. Grether and I are now able to evaluate their frequent erroneous records in the light of our large collections and the observations of numerous field trips. There are now 55 species known from there, of which 8 have never before been recorded. The results of our collections in the Admiralties are even more striking, the known number of species now being 165, whereas, so far as we can discover, only 39 had been reported earlier. We expect in the near future to publish papers on the pteridophytes of this group also, based on our "extracurricular" studies while in the service.[2]

Among the most ardent and capable of the writer's collector correspondents was Lieutenant George B. Van Schaack, USNR, stationed on Attu Island at the western end of the Aleutian chain. He was a college mathematics teacher and amateur botanist before the war, entirely unacquainted with collecting. To me he wrote, in part, as follows:

> Making a collection of plants was probably one of the last things any serviceman ordered to duty in the Aleutian Islands expected to do. The islands had been played up so prominently as completely desolate that it is doubtful if any of us expected to see so much as a blade of grass. It is perhaps because of this very fact that, when the full beauty of the summer vegetation there burst upon us, so many found an interest in the flowers who, back home, had taken the summer greenery and bloom for granted. Privates and majors, seaman and captains, were then to be found picking flowers and either send-

[2] Lt. Wagner has told about his "Fern Hunt in Puerto Rico" while flying for the Navy in the Caribbean region in the *American Fern Journal*, 35, (1), 1945, 4–9, illus.

ing them home in cellophane wrappings via air mail or pressing them in magazines to take home when the long-looked-for day of leave should come. A few of us, having a slight knowledge of the scientific importance of accurate and complete data on the flora of a region, and realizing the probable paucity of such information for the Aleutians, went further and attempted to make large collections of scientific significance. Important collections of this type were made at Dutch Harbor, Atka, Adak, Amchitka and Kiska, but, so far as I know, the largest and most complete collections were made on Attu Island, the most remote member of the Aleutian chain.

Altogether, these collections total between three and four thousand numbers and between three and four hundred species. This makes possible a fairly wide distribution of specimens, and the interests of the several collectors are such that a number of different institutions will benefit.

It is unlikely that many of the persons who found such interest in the flowers of Attu would care to return to the island under any circumstances. But I feel sure that all of them will, in varying degrees, remember their exile on Attu with less bitterness for having had that interest.

Captain L. T. Burcham, First Marine Division, before the war was a Range Examiner with the U. S. Department of the Interior, affectionately dubbed in Western states a "grass counter." Unlike most of the collectors before mentioned, he was well versed in botany and plant collecting, especially of grasses, before entering the service and needed no serviceman's collecting program to stir him to "make hay." Following are two extracts from an assemblage of botanical notes which he gathered from his letters home for my use in preparing this article. His delightful descriptions of the vegetation and of the striking plants and animals he found will be published in full in a subsequent issue of THE SCIENTIFIC MONTHLY.

From Guadalcanal in December 1942 he says:

My well-laid plans for collecting grasses in New Zealand have gone sadly awry. On a few hours' notice I found myself boarding a plane. There have been compensations; I have started gathering specimens of the local grasses. Even the problem of securing plant driers has been unexpectedly solved for me. I had to leave all mine behind because of weight limitations on baggage and naturally had anticipated difficulty in obtaining any material suitable for drying plants. However, within a day or so of arrival we received a shipment of aerial photographs, which had been printed and dispatched to us while wet, packed between sheets of heavy blotting paper. These I carefully salvaged, dried in the sun, and am now using them in drying specimens. Interestingly enough, my collections are faintly reminiscent of ancient history, for among the first lot of grasses was one known as jungle rice (*Echinochloa colonum*). Husks from the grains of this grass have been found in the stomachs of mummies taken from some of the earliest graves in the Nile Valley. It is not now cultivated.

After being in the Palau operation and spending a day on the undevastated eastern side of Peleliu Island, he wrote:

That trip gave me an opportunity to look at the vegetation of these small, sandy coral islets. I've collected some specimens of the grasses and will continue as soon as this rainy spell lets up. My plant press here is the pages of a Jap military manual that was printed on newsprint! A trifle small, but it suffices.

Few want to remember the military experiences of World War II, but few will forget the lighter hours given to natural science. The equipment for war is being destroyed, but the scientific specimens are being preserved. The opportunities for productive scientific enterprise by the occupying forces are still available. Will they be seized upon or wasted? Those in need of scientific collections are still ready to send aid and encouragement to any likely collector or possible future biologist.

EARLY CHINESE JADE

By A. G. WENLEY

DIRECTOR, FREER GALLERY OF ART

THE term jade is properly used to designate two particular types of ornamental stone, known respectively as nephrite and jadeite.

Chemically, nephrite is a silicate of calcium and magnesium, $CaMg_3(SiO_3)_4$, and is a mineral of the amphibole group. It is of a tough, compact, fibrous structure, so finely grained that magnification is necessary to observe it. The fibers of which it is composed may be arranged parallel to each other, curved, twisted, interlocked, or felted, perhaps superficially resembling more than anything a tremendously compressed asbestos. According to Moh's scale, it has a hardness of from 6 to 6.5, and its specific gravity is from 2.96 to 3.1.

Jadeite, on the other hand, is one of the pyroxene group of minerals, the chemical composition being an aluminum sodium silicate, $NaAl(SiO_3)_2$. It has a hardness of from 6 to 7 and a specific gravity of from 3.3 to 3.5.

In contradistinction to nephrite, jadeite has a vitreous luster, being crystalline rather than fibrous in nature, giving it when polished a shiny appearance, whereas nephrite has a rather waxy appearance. To distinguish between these minerals, which so strongly resemble each other, microscopic examination and chemical analyses are necessary.

Another mineral which may be regarded as a variety of jadeite is chloromelanite, which contains large amounts of iron—as much as 10 percent—and varies in color from dark green to almost black.

Both nephrite and jadeite, in an absolutely pure form, should be white with no color. Actually, however, a variety of colors exists in these stones owing to the presence of other elements. For example, the green of jadeite may be due to the presence of chromium, while nephrite often contains small quantities of iron. However, the Chinese term *yü*, which we generally translate as "jade," has been used through the ages to cover a wide variety of decorative stones capable of taking a soft, lustrous polish. Of these, nephrite and jadeite of course are the ones to be considered as true jade, but from earliest times to the present day other, softer, materials, such as agalmatalite, bowenite, marble, and many others have been used for carving purposes. In color these stones range from black to white, with shades of yellow, russet, fawn, brown, gray, green, blue, and even purple in-between. Thus it is impossible to make any differentiation by means of color alone. Hardness and specific-gravity tests are not conclusive, but occasionally they may enable one to tell fairly quickly whether or not a given stone comes within the range of nephrite, jadeite, or chloromelanite.

Both nephrite and jadeite seem to occur in a number of places throughout the world, and new discoveries of deposits of these minerals are made from time to time. To give a general idea of its distribution, we may say that nephrite, for example, has been discovered in Silesia and in the Alps in Europe. It also seems to occur in a number of the Pacific islands, including the south island of New Zealand, where it occurs in quantities, and also New Caledonia. A dark-green nephrite comes from Siberia, near Lake Baikal, and in Turkestan there are quarries in the Karakash and Yarkand river valleys from which a great deal of the nephrite

Freer Gallery of Art, No. 40.10

CEREMONIAL SICKLE

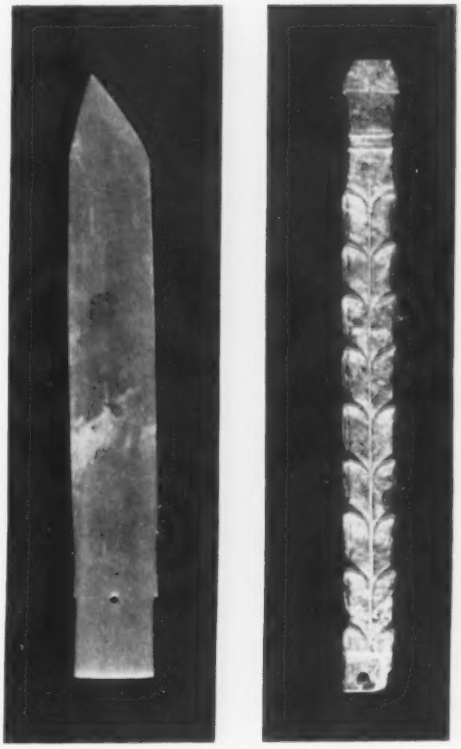
THE BLADE OF JADE AND HANDLE OF BRONZE ARE INLAID WITH TURQUOISE. .345 × .175 M. OVERALL. SHANG DYNASTY, 14TH-12TH CENTURY B.C.

used by the Chinese is taken. Jadeite is found chiefly in Burma around the tributaries of the Irrawaddy River in the North, and objects of jadeite are common in Mexico, Central America, and the northern part of South America. Jade seems not to have been known in the Western world until sometime in the sixteenth century, after the Spanish Conquest of Mexico, although it was actually known to our neolithic ancestors in Europe, where artifacts have been found in various neolithic sites, particularly in Switzerland. Thus our word jade is a late addition to our language, coming ultimately from the Spanish *piedra de ijada*, or "the stone of the side," since the stone was applied as a medicine for a pain in the side. The word nephrite also has a medical origin, coming from the Greek *nephrit*, the "kidney"; it was known as the "kidney stone" and used as a specific for kidney pains.

In China, however, jade appears to have been used literally for ages, that is to say, from mesolithic times, that period just between the Old and New Stone Ages, up to and including the present day. It is small wonder, then, that among the Chinese this stone has been revered as the mineral par excellence. Throughout Chinese literature all that is fine and good is compared with jade. Indeed, it has been said that the ancient Chinese considered it as the essence of power or virtue rather than simply as a precious stone, and the fact that they utilized even the smallest fragments of it shows in what great value it was held. Where we of the West might say "as pure as gold," the Chinese might say "as pure as jade." Comparable to our expression "a diamond in the rough" as referring to persons, an old Chinese adage says, "As an unpolished jade is an unfinished article, so a man without learning is without understanding." It is valued no less in modern times, and in 1889 a book known as the *Yü p'u lei pien* was published in four chapters giving references to jade from all branches of Chinese literature. The finest qualities of jade in China come either from Northern Burma or from Sinkiang, Chinese Turkestan. The rough article taken from quarries, or mines, is known as *shan liao*, or "mountain material." Pebbles or boulders of jade taken from river beds are known as *tzŭ yü*, or "seed jade."

Jade is a very hard stone, and the carving and cutting of it are very exacting, requiring much time and patience.

How the ancient jades of the Shang (*ca.* 1766–1122 B.C.) and Chou (*ca.* 1122–207 B.C.) dynasties were carved cannot be explained in any detail. Suffice it to say that from the discoveries made at the excavations at Anyang, in Honan, evidence has been found that the Chinese jade carver already was using a rotary blade for sawing, a pointed drill for drilling, and fine sand as an abrasive. However, we do know that by about 1400 B.C., the Chinese jade carver apparently had a perfect command of his tools and materials, as can be seen by the beautiful objects wrought at that time. It is also pertinent to note here that evidently the jade mineral used at that time was found somewhere in the districts near Anyang. This is extremely interesting, for up until this discovery we could not be absolutely sure where the ancient Chinese obtained their raw materials.



Freer Gallery of Art, Nos. 39.21 and 39.31

BLADE AND DAGGER HANDLE

Left: MINIATURE BLADE OF JADE. LENGTH .171 M. CHOU DYNASTY, CA. 5TH–3RD CENTURIES B.C. *Right:* CEREMONIAL DAGGER HANDLE OF JADE. LENGTH .178 M. FROM THE SHANG DYNASTY.

In modern times, the carving of jade may be divided into several parts. To begin with, the rough stone is carefully studied, and plans drawn so that every part of it may be utilized. Next comes the job of dividing up or roughing out the stone to the general shape desired. If it be a large boulder, it is put under a large, swinging, soft-metal knife which is swung backwards and forwards, gradually sawing its way through the stone by means of water and an abrasive. Smaller stones or the stones derived from the larger blocks are then roughly shaped by being held against a primitive circular blade of soft metal. This is worked by pedals from which lines go to either side of the arbor, or axle, on which the disc is mounted, each line wrapping around the arbor in an opposite direction, so that when the pedal pressure is applied, the saw rotates six or more times in one direction and then six or more times in another. By feeding abrasives to the cutting surface, the saw gradually works its way through and the object is roughed out. From this rough sawing, the piece next goes to the carver, who utilizes a smaller disc blade and abrasive and also a diamond drill. Needless to say, the last and final careful carvings are done by only the most experienced of the carvers in the shop. The whole process is extremely time consuming and requires great skill and patience, although in recent times the use of carborundum as an abrasive and also the diamond drill has to some extent hastened the process. The last step in the whole procedure is polishing. For this, gourd fiber is widely used, and occasionally the product is given an acid bath. Finally paraffin is employed.

How far removed these modern processes are from those used in ancient times, it is impossible to know at present, although no doubt much of the old technique persists along with the more modern developments. It is to be hoped that the introduction of modern power-driven devices will not cheapen, or detract from, the works so beautifully done today.

Among the really fine hard stones used to make various articles in ancient China, nephrite appears more generally than jadeite, and other varieties of stones, perhaps anciently mistaken for nephrite, also appear in some quantity. These were manufactured into objects of a variety of shapes and decorations. We know, as yet, comparatively little of the early Chinese culture which produced these objects, but it is safe to say that the broad basis of early Chinese civilization was agricultural and that religion was, in general, animistic, or concerned with nature worship. Added to this was the necessity of protecting agricultural holdings from intrusions of other peoples and the extension of such holdings by means of excursions against bordering peoples. This necessitated some sort of military establishment. We have, therefore, three essential factors on which the conduct of the community was based—agriculture, religion, and war. These, it seems fair to suppose, gave rise to the forms of implements connected with governmental and religious ceremony, and these two were naturally very much intermingled; hence, many of the jade forms no doubt represent either military or agricultural implements made to be used for civil or religious ceremonial purposes. We may thus divide these objects into four general types: religious symbols, badges of office, funerary offerings for the dead, and ornamental objects.

Attempts have been made to identify the various jade forms with the descriptions appearing in early Chinese texts. While such identifications are by no means certain, we use the following list for the general idea it gives today as to the use and importance of jade in early Chinese culture. Under the first heading, religious symbols, we have: (1) a perforated disc, called *pi*, sometimes called the symbol of the deity Heaven; (2) the squared hollow cylinder *ts'ung*, sometimes called the symbol of the deity Earth; (3) the "ring" *pi*, *huan*, sometimes called the symbol of the deity North; (4) the green tablet *kuei*, sometimes called the symbol of the deity East; (5) the red tablet "half-*kuei*," *chang*, sometimes called the symbol of the deity South; (6) the tiger tablet *hu*, sometimes called the symbol of the deity West; (7) rings, flat or round, used as offerings.

Under the second heading, badges of office, we have blades, tablets, and certain forms resembling axheads, chisels, scrapers, etc., some of which seem to have been derived from earlier Stone-Age weapons and tools and to have survived as objects of ritual, carried or worn by persons as emblematic of their official rank.

Under the third heading, funerary offerings, we may include any of the above items, also various amulets to be placed on or in various openings of the corpse such as the mouth and eyes, as well as garment ornaments of one sort or another. It is worthy of note here that many of these funerary offerings apparently were placed in the grave purposely in an unfinished condition. Thus we may find, for example, a jade halberd, beautifully carved on one side but unfinished on the reverse.

Under the heading ornamental objects, we have necklaces, headdress ornaments, girdles, and dress ornaments; fittings for swords, scabbards, and weapons of various kinds; tallies and seals; carvings of animals, fishes, birds,

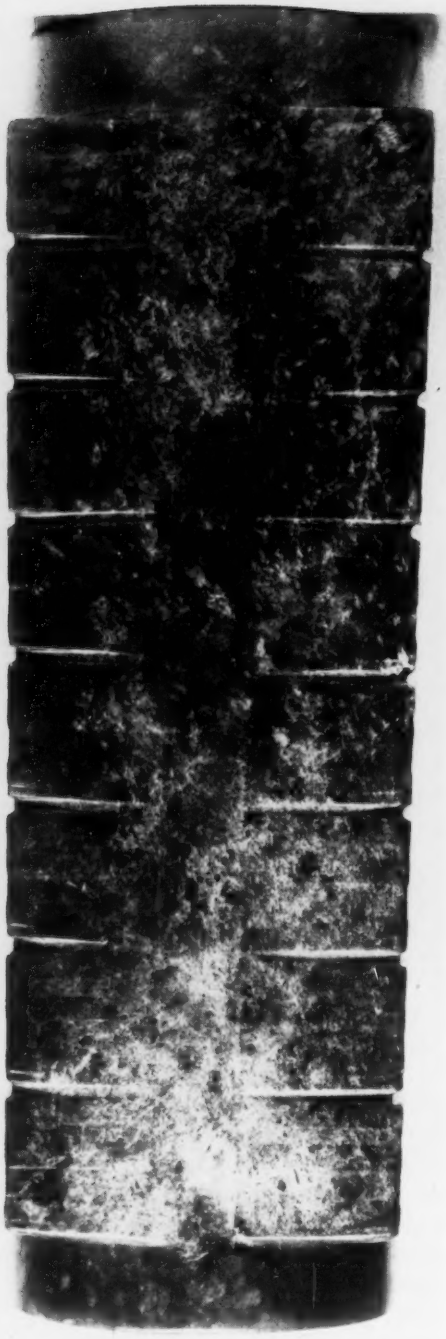
Freer Gallery of Art, No. 19.85

PERFORATED JADE DISC *PI*

A SYMBOL OF THE DEITY HEAVEN. DIAM. .226 M. CHOU DYNASTY, FIFTH–THIRD CENTURIES B.C.

monsters, and insects. All these, however, may also be indicative of rank, or they may be offerings or gifts of one kind or another. Aside from their shape, the ornamentation of these objects, often done with incredible skill, includes line engravings, relief carving, or countersunk relief carvings; and sometimes all three are present on one object. As for patterns, there are linear arrangements, such as fillets and zigzag lines, both simple and interlaced, forming lozenges and scrolls of various kinds, including the so-called thunder-and-cloud scrolls. Animalistic designs are monster forms, the dragon, the cicada, etc. A serrated edge ornamentation of silhouette characters is peculiar to early Chinese jades and cannot be explained. There is also the grain pattern, which is composed of tiny bosses.

In addition to the above uses for jade, we must not forget that this ornamental stone has always been used for many



Freer Gallery of Art, No. 18.14
SQUARED HOLLOW CYLINDER
Ts'ung SYMBOL OF DEITY EARTH. 207 × .069 M.
THE CHOU DYNASTY, 5TH–3RD CENTURIES B.C.

utensils of various kinds: cups, bowls, pots, dishes, seals, writing-brush handles, musical stones, and even flutes of jade. Also we find various objects of jade used for room decorations: jade carved in figures, jade carved as landscapes, jade slabs engraved with poems, jade carved as fruit and flowers, besides images of Gods and Worthies of Chinese mythology.

Today, the main value of these objects is in the quality of the material and the excellence of the workmanship, and it follows that usually the finest workmanship is found upon the best material. However, it must not be forgotten that jade deteriorates in burial, and some of the early jades we have today which perhaps once were nephrite, have changed chemically through the action of the soil and the passage of years. It is this decomposition of materials which makes specific-gravity and hardness tests virtually worthless when dealing with certain of our archaic jades.

This is borne out by specific-gravity tests made recently upon the jade collection at the Freer Gallery of Art. Tests of 32 of the Shang dynasty pieces showed that 17 were below the specific gravity of nephrite. Of these 17, 9 displayed a considerable state of decomposition or had earthy incrustations or other foreign matter adhering to them. These probably were all nephrite in their original state. The 8 pieces left were either definitely of other material in the beginning or were completely disintegrated, and the change had been so serious that it was impossible to say what the original stone might have been. In a group of 217 Chou dynasty stones weighed, 131 proved to be below the weight for nephrite specific gravity. But here again a great many of these were badly decomposed or had earthy adhesions or other foreign matter on them which affected the reading of the true specific gravity. As a qualitative study, we may take then

just the 15 Shang nephrites and the 86 Chou nephrites which stood the specific-gravity tests. Of the Shang nephrites, 13 are large ceremonial implements and weapons of fine quality material, with strong lines and finished workmanship. There is very little decomposition in these. Three smaller decorated pieces of light, translucent material have been well handled in composition and design. Fifty-four of the early Chou pieces comprise mostly undecorated *pi* or *ts'ung*, with the regulation designs, and plain *kuei* of various forms. The *pi* and the *ts'ung* are mostly of dark, closely mottled, varicolored materials with little or no translucence and with a strong tendency toward white decomposition, especially in the veins. The *kuei* are usually a solid color or two-tone, with little or no decomposition. Thirty-two late Chou pieces show a decided change in material and decoration. The 6 *pi* are translucent and mostly of light colors. All are decorated with the "grain" pattern in relief and incised. The remaining pieces, cups, rings, ornaments, and jewelry, are of light, translucent material with a tendency toward a cloudy white, or milky, opaque surface alteration. They all have the superb workmanship and design characteristic of this period, which is unsurpassed before or since. If we speak of the value of these jades in the terms of intrinsic value, there is obviously only one value, and that is "scarcity" value. This, in turn, depends upon the condition of the market and the circumstances surrounding the acquisition or sale of such things. Market values, furthermore, may fluctuate to a greater degree even than those of our stock market. The true value is that of quality; quality in conception, execution, and materials, and that is a great moral lesson which may apply to everything made in this world. The aesthetic appeal of jade exists in China to the present day. It is valued not only for its beauty as a stone that appeals to the eye, but equally for its appeal to the touch. As we have seen, it is extremely hard and very difficult to work, and the fact that we have both extremely simple and highly ornamented objects of this material dating from very early times is an indication of its two-fold appeal.

Freer Gallery of Art, No. 30.27

AN ELABORATE NECKLACE

CONSISTING OF FOUR STRANDS OF BRAIDED GOLD WIRE, WITH TEN JADE OBJECTS ATTACHED TO IT. LENGTH IS .407 M. FROM THE CHOU DYNASTY.

JAMES SMITHSON

"My name shall live," he said, "my name shall live
In the memory of man when vain titles
Are forgotten. But who am I to boast?
You ask me my name. Well, I will tell you . . .

"My father was the most high, puissant,
And noble prince Hugh Percy (born Hugh Smithson),
The Earl and first Duke of Northumberland,
Earl Percy, Baron Warkworth and Lovaine,
Lord Lieutenant and Custos Rotulorum
Of Middlesex and Northumberland Counties
And of all America, and a Lord
Of His Majesty's most Honorable
And Privy Council and Knight of the most
Noble Order of the Garter, et cetera—
One of the handsomest men in all England.
And my mother? Elizabeth Keate Macie,
The heiress of the Hungerfords of Studley,
A widow, and descended from a King . . .
The best blood of England flows in my veins,
Yet this avails me not. But who am I?
I am James Lewis Macie, or James Smithson,
A commoner, born in France out of wedlock,
Master of Arts from Pembroke College, Oxford,
Fellow of the Royal Society.

"Yes, once I thrilled at the great name of Percy:
Like Sidney, two hundred years ago now,
'I never heard the ancient song of Percy
And Douglas that I found not my heart moved
More than with a trumpet.' Save for a marriage
I'd be a Percy too. I've felt it keen,
But think me not bitter about it now—
That was long ago. Now I'm getting on:
I am sixty-one and must think of death;
I am lonely and ill; there's not much left
For me—two, or three, or four years, perhaps . . .

"No ignorance is without loss to man,
No error without evil, and therefore
I have loved truth and have dabbled in science;
That has been my pleasure, and it may be
(Who knows?) I have enlarged those lurid specks
In the vast field of darkness. But also
I have loved fame, that 'last infirmity
Of noble mind.' 'Fame is the spur,' said Milton.
Now by this earth's wealth which has come to me
I vow to make it true as I have dreamed:
The name of Smithson shall be linked with truth
And with the spread of knowledge through the world,
For ignorance has been my enemy
As it is all mankind's."

So having said,
With deliberate speech and firm countenance,
He took up his pen and began to write
These bare words:

"I, James Smithson, son to Hugh
And Elizabeth . . . this twenty-third day
Of October, year eighteen twenty-six,
Do make this my last will and testament . . .
And I bequeath . . . to the United States
Of America all my property
To found at Washington an Institution . . ."

So was his duty done, his dream reborn.
"I shall not altogether die," he said;
"Smithson shall live when Percys are extinct,
Until the world at last shall know the truth
And be forever free."

PAUL H. OEHSER

A BRIEF HISTORY OF THE ZOO

By WILLIAM MANN

DIRECTOR, NATIONAL ZOOLOGICAL PARK

"THE House did not report the same."

This is from the report of the Secretary of the Smithsonian Institution for the year ended June 30, 1889. "The same" was a request for $5,000 for the care and maintenance of the United States National Museum's department of living animals, of which William T. Hornaday was curator. The animals had come in as gifts to the government, and their number was increased during the following year by a trio of American elk sent by the Honorable W. F. Cody (better known as Buffalo Bill), of North Platte, Neb., 4 American bison from Dr. McGillycuddy of Rapid City, Dak., and gifts from various United States Army officers stationed in Texas.

Animals were accepted reluctantly. There was little place to keep them, and most of them were in an overcrowded, steam-heated temporary building, filled during visiting hours with enough sightseers to make it uncomfortable. There was no appropriation wherewith to buy feed for the animals, and the limited funds of the Smithsonian had to be used. Some of the animals served as models for the taxidermists who were mounting North American animals for the National Museum and were afterward sent to the zoological gardens already established at Philadelphia or Cincinnati or to the New York Central Park menagerie.

The previous year, 1888, Senator Beck of Kentucky had brought before the Senate a bill for the formation of a zoological park. This did not pass. In 1889 a bill sponsored by Senator Edmond was passed for the establishment of a National Zoological Park in the District of Columbia for "the advancement of science and the instruction and recreation of the people," and $200,000 was appropriated to purchase and improve the site for the Zoo. A commission consisting of three persons was appointed: The Secretary of the Interior, the President of the Board of Commissioners of the District of Columbia, and the Secretary of the Smithsonian Institution.

This committee selected the site of the present Zoo,

> . . . . a site in the picturesque valley of Rock Creek, in the portion nearest the city. Here not only the wild goats, the mountain sheep and their congeners would find rocky cliffs which are their natural home, but the beavers brooks in which to build their dams; the buffalo places of seclusion in which to breed, and replenish their dying race; aquatic birds and beasts their native homes, and in general all animals would be provided for on a site almost incomparably better than any now used for this purpose in any capital in the world (Letter from Secretary Langley to Congressman Samuel Dibble).

Largely featured in correspondence concerning the Park at that time was the preservation of North American animals on the verge of becoming extinct, especially the bison.

Mr. Hornaday resigned at the end of the year, and Dr. Frank Baker, honorary curator in the Department of Comparative Anatomy at the National Museum, was appointed as "Acting Manager" of the Park. Mr. W. H. Blackburne, of the animal department of the Barnum and Bailey Circus, was put in charge of the animals; he was given the title of Principal Keeper. He stayed 53 years and is still consultant to the Director.

A bridge was put over Rock Creek; destroyed by a freshet the following year, it was rebuilt immediately. Roads were made. In 1892 there was a deficiency appropriation of $1,000 for the care and subsistence of animals, half to

be paid by the treasury of the District of Columbia and half to come from the Treasury of the United States. The annual report for that year gave the first census of the collection of 406 specimens.

A firm of landscape architects, Olmsted and Eliot, was engaged to plan improvements in the Park, and land was added, a few acres at a time, purchased from different owners. Mr. H. P. Waggaman made a gift of over an acre. The road at the entrance was graded to make it practicable for carriages, the Zoo at that time being "a pleasant carriage ride from the city." Editorials proclaiming the undoubted future greatness of the Zoo appeared in leading papers throughout the United States.

During the first year a buffalo cow, annoyed by a visitor, broke through the fence and charged at a nursemaid, who diverted it from the baby she was tending; a brave spirit spat tobacco juice in a bear's eye and was fined $5.00; an editorial appeared in a Washington paper decrying "saddling cost of Zoo on District"; one front-page cartoon showed the District of Columbia as a small boy with a patch on the seat of his pants, threatened by the Appropriations Committee in the form of an Italian organ-grinder carrying a monkey labeled the "National Zoological Park." He held a knife, the "Appropriations Snickersnee," ready to drive into the lad, and the legend ran: "Adrone Giuseppe Cannoni to the District—'Gimma da Mon to Feeda da Monk or I cutta da Troat.'"

The Quincy, Ill., *Herald* stated in an editorial that the Zoo "will soon be a credit to the Nation, but should be paid for by the Nation and not by the District." Editorials in other papers discussed the rapacity of the Washingtonians unwilling to pay the costs of a Zoo for their own benefit. After 56 years

AMERICAN BISON

ONE OF THE REASONS FOR ESTABLISHMENT OF THE NATIONAL ZOOLOGICAL PARK.

the subject is still brought up annually. One may state now that on big days at the Zoo there are cars from every state in the Union and one or two cars also from Alaska, Canada, the Canal Zone, Hawaii, and Puerto Rico.

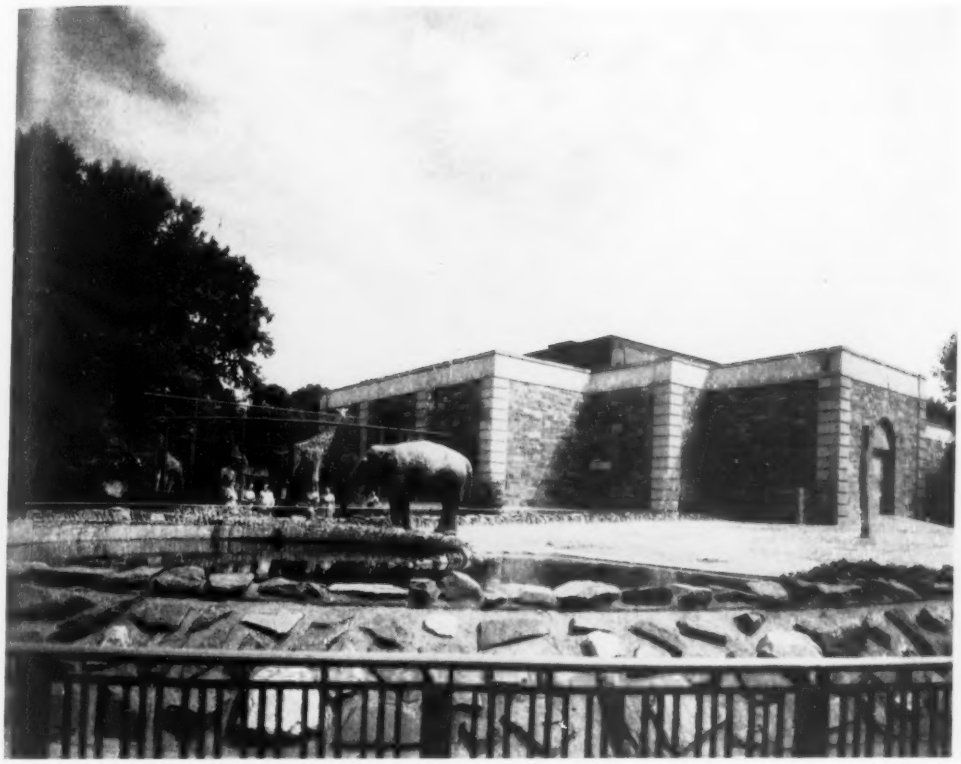
In the early days there was no money to buy animals, but some funds were available to collect them. An unsuccessful expedition was made to Alaska to secure the large brown bears. Then, by permission of the Secretaries of State, War, and the Navy, the Zoo sent a circular to officials abroad requesting animals and giving instructions for their care and shipping. The results were surprisingly good. The Governor of Pará sent a large shipment, and Commander Todd of the U. S. S. *Wilmington* brought from Brazil 18 animals, including a tapir and the very rare harpy eagle. Alexander Graham Bell brought mandarin ducks from the Zoo in Tokyo, Japan. Yellowstone Park contributed elk and deer, and the superintendent there thought it would be possible to catch a grizzly bear. Accordingly, a trap was made at the Zoo and shipped to the park, and a grizzly was caught. Two raccoons were captured in Rock Creek Park, and the President of the United States presented an opossum, probably a wild one from the White House grounds. Eight black squirrels came from the Toronto Park Department and were liberated. There are now dozens of these thriving in the Park.

F. W. Goding, of Newcastle, New South Wales, sent an assortment of 140 specimens, including echidna, flying phalangers, a Tasmanian wolf, a Tasmanian devil, and 30 parrots and cockatoos, following this shipment the next year with 15 specimens, including a mate for the Tasmanian wolf.

The U. S. Fish Commission ship, *The Albatross*, brought an even dozen of elephant tortoises from the Galapagos. After the Spanish-American War, the Army sent various lots of specimens, including an amazing shipment of 15 Cuban crocodiles (*C. acutus*). At the present time a single specimen of this

Photo by W. R. Schufelt

THE FIRST ELEPHANT HOUSE



EXTERIOR OF THE NEW LARGE MAMMAL HOUSE

crocodile in captivity is unique outside of Cuba.

James E. Cooper, owner of the Adam Forepaugh Shows, presented a pair of elephants, Dunk and Gold Dust. Gold Dust soon died, but Dunk remained a popular figure in the Zoo for more than a quarter of a century. Many years later, Ringling Brothers Barnum and Bailey Circus presented Babe, one of their historic elephants.

In 1893 many animals of the Forepaugh Show were deposited for the winter in the Park; some arrived in circus menagerie wagons and were quartered with dromedaries, zebus, and llamas in a temporary stable. The Zoo was to receive half the animals born during the winter, and the net result was one baby kangaroo. However, it is interesting to know that the only hairy-eared Sumatran rhinoceros ever exhibited here was lent by the circus and represented this species for the first and last time in Washington, and perhaps in America.

The King of Abyssinia presented President Theodore Roosevelt with some gelada baboons, a lion, and a Somali ostrich; the ostrich lived for 26 years. An exchange was made with the New Zealand government, and a kiwi and a tuatara lizard were put on exhibition. The following year Ras Makonnen, the Governor of Harrar Province in Abyssinia, sent zebras and lions; the Swiss government sent 5 chamois; and W. M. McMillan, of Nairobi, East Africa, offered such a sizable collection that the Assistant Director of the Zoo, Mr. A. B. Baker, journeyed out there and brought back lions, cheetahs, leopards, gazelles, and wart hogs as gifts and a considerable

number of smaller species that he collected himself.

By 1895 the Zoo's collection was so well established that 13 animals were loaned to the Adam Forepaugh Shows, probably in return for their previous gifts of 2 elephants.

By 1910 there was an average of more than 1,400 visitors a day in the Zoo.

Secretary Langley was fond of coming to the Zoo, where he not only was able to get away from crowds, but also, on a platform built in an oak tree in the Park, to observe the flight of vultures and other birds; afterward he would make his calculations in a quiet room in the Zoo offices. Thus the Zoological Park is closely associated with the early studies of aeronautics in America.

In the early days of the Park the Appropriations Committee of Congress seemed to have a habit of doing things by halves: $35,000 was asked for maintenance, and $17,500 was appropriated; $36,000 for improvements was cut to $18,000; and when $20,000 was begged in order to build an elephant house, $10,000 was granted. This did not build a very large elephant house, but it served for 35 years, when it was replaced by a $287,000 pachyderm house.

In 1913 the government zoological gardens at Giza, Egypt, offered a collection of interesting things, and Mr. Blackburne sailed to get them. He brought back a pair of African elephants, cheetahs, 3 dromedaries, and several other specimens. Jumbo II, as the male elephant was named, died after 3 years, but the other, Jumbina, is still living. Moving her from the quarters she had occupied for nearly a quarter of a century to the new pachyderm house, in 1937, was a formidable task. A strong crate was built, and the elephant, once inside it, was hauled up on a low flat truck to make

EXTERIOR OF THE BIRD HOUSE

EAGLES LIVE IN NATURAL SURROUNDINGS

the move. Since then Jumbina continues to look with disfavor on the Zoo's boss mechanic, whom she evidently associates with certain indignities connected with the ride.

In 1916 the Duke of Bedford sent Kashmir deer and eland, and the Canadian government some Rocky Mountain sheep.

In 1917 Dr. Frank Baker resigned after 26 years of service, and his place was taken by Ned Hollister, of the Biological Survey. At this time Mrs. Charles D. Walcott, wife of the Secretary of the Smithsonian, campaigned among her friends in the city and raised enough money to buy a pair of Sumatran elephants, Hittam and Kechil. Kechil is still living, but Hittam died many years ago. F. W. Goding, who had sent the Australian collection, turned up again, this time as consul at Guayaquil, and sent some Galapagos tortoises.

Other friends and Zoo fans continued to donate specimens; some of them—for instance, Captain Kellers, of the U. S. Navy, and Victor J. Evans, of Washington, D. C.—were steady contributors year after year, and these contributions, with funds at last available to purchase animals, steadily improved the collection.

Under the auspices of Austin H. Clark, of the National Museum, a series of 31 radio talks was given in 1926, through the cooperation of Station WRC, and each talk included a brief statement of current news at the Park, usually by the Director, who then introduced the speaker of the evening.

Ned Hollister died in 1924, after 8 years as an able superintendent of the park, and was succeeded by Dr. Alex-

ander Wetmore, who served for 5 months, when he was appointed Assistant Secretary of the Smithsonian. He was followed by the writer, in 1925.

THE following year was a momentous one. Walter P. Chrysler, taking an interest in the Zoo, financed the first expedition that had been possible since those of the very early days of the Park. A group of four collectors went to Tanganyika, East Africa, returning after seven months in the field with over 1,600 specimens, including a pair of giraffes, the first ever in the Zoo, 30 antelopes, leopards, wart hogs, and much smaller stock. This increased the collection from its previous high of 1,600 specimens to 2,400, a standard that has since been maintained.

Mr. Chrysler permitted the Smithsonian to keep funds that had not been expended on the expedition, and with these were purchased N'Gi, our first gorilla, and saddle-billed and shoebill storks—all spectacular. Despite the fact that it was a very cold day, 40,000 visitors were on hand to see N'Gi when he was placed on exhibition.

Following the Chrysler Expedition, the National Geographic Society financed another one to the Netherlands East Indies (and, incidentally, around the world), resulting in a large assortment of rare small things, a quartette of Nubian giraffes, a pair of gaur from India, and quantities of East Indian birds and reptiles, including 18 birds of Paradise, many rare lories, and a young Komodo dragon lizard about 6 feet long.

In 1940 the Firestone Rubber Company, through Harvey Firestone, Jr., invited the Zoo to send an expedition to Liberia, West Africa, to collect animals, using the rubber plantation as headquarters. Pigmy hippos, several species of small duiker antelopes, monkeys, and rare birds and reptiles were obtained for the Zoo by this expedition.

In 1926 the Congressional Committee on Appropriations had decided that the Zoo did need a new bird house. Money was appropriated, and the building constructed as far as the funds permitted. This was followed by appropriations for a reptile house. Through Smithsonian financing, the Director was able to take Mr. Alfred Harris, the Municipal Architect, to Europe, where all of the worthwhile reptile exhibitions were visited and studies made of the buildings. While the house was being constructed, a short expedition was made to Central America to collect reptiles for the exhibition. The building was opened at a reception in February and stocked with the specimens that had been kept here and there about the Zoo.

The reptile house proved so popular that one evening a Congressman, a friendly member of the Zoo Appropriations Committee, came to the Director and said:

> We realize that the building program for the Zoo that you have suggested so many times is a good one. But on both of the houses that you have constructed, mistakes were made in estimating their cost. We have decided this year to give you money for plans and specifications for the next building, so that you may make a better estimate of the cost. Then when that is being built, another fund for plans and specifications for the following one.

It sounded good, and the building program seemed practically assured. But there was an election, and the chairman of the committee soon returned to his law practice in Nebraska and the friendly Congressman to his farm in Illinois, leaving the Zoo in the midst of the depression with an entirely new and strange committee. There were no more appropriations for buildings, but through some of the relief agencies considerable work was done: ponds for waterfowl were constructed and other improvements that could be made without expensive materials.

The committee had appropriated the

Photo by E. P. Walker

EMPEROR PENGUINS, JACKASS PENGUINS, AND KELP GULLS

ALL THESE BIRDS WERE RECEIVED FROM THE ANTARCTIC AND ARE KEPT IN REFRIGERATED QUARTERS.

sum of $2,000 a year for collecting trips. One was made to British Guiana and one to the Argentine, each resulting in many interesting additions to the collection. A trip to India resulted in the addition of the rhinoceros collected by the Forestry Department of Assam.

In 1935 the Zoo had a great stroke of good luck: The Public Works Administration allotted $680,000 and followed this the next year with $191,000, with which were constructed machine shops, a central heating plant and working facilities, a small mammal house, and a pachyderm house; the bird house was completed, thus giving the Zoo four of the best buildings in the world but leaving three of the most unsatisfactory.

During World War II the Zoo was maintained at almost its normal level; the 48-hour week, put into effect by the government, made up for the decrease in personnel, so the collection was never neglected. Substitutes were necessarily used for numerous ordinary supplies. When flour was scarce, there were utilized great quantities of macaroni products that had been condemned by the United States Marshal and given to the Zoo; a few dried bananas were secured from time to time; Mexican dried insects replaced the ant eggs that had hitherto come from Germany and Japan.

The Army and Navy, especially the Army Medical Corps, sent numerous shipments of specimens, some of them

ex-mascots primarily for exhibition, and others for research; for example, venomous habu snakes were sent from Okinawa so that studies could be made of the venom and the right serum for treatment developed.

IN THE first half-century of its history, the Zoological Park exhibited many creatures that probably will never be seen again in captivity: the West Indian seal, now practically extinct; Tasmanian wolves with young; kiwis from New Zealand; and California condors, one of which has lived 45 years in the Park. At the present time the Zoo contains a representative collection of mammals, birds, and reptiles of the world, with small exhibits of fish and insects. Its popularity is attested by the attendance, which numbers well over 2,000,000 each year. Thousands of school children in organized classes, artists, photographers, and students of natural history show that the Park is functioning in the purposes for which it was established.

WILLIAM MANN

WILLIAM MANN, Sc.D., has been Director of the National Zoological Park since 1925. He was born in Helena, Mont., July 1, 1886. It would be interesting to know how many miles he has traveled during the past sixty years. He studied from one side of the country to the other: Staunton (Va.) Military Academy, State College of Washington, Stanford University (B.A., 1911), and Harvard University. At Harvard he was a graduate student at the Bussey Institution, specializing on ants under William Morton Wheeler. Like Wheeler, Dr. Mann spent as much time as possible studying zoology and entomology in the field. During all vacations he collected natural-history specimens, making trips to Mexico, Cuba, Haiti, western Asia, and South America. Taking his Sc.D., in 1915, he collected in Fiji, Australia, and the Solomon Islands as a Sheldon Traveling Fellow of Harvard. From 1916 until he became Director of the Zoo he was in the Bureau of Entomology of the U. S. Department of Agriculture. Even there he managed to travel, investigating insect pests in the American tropics and in Europe. And in 1922 he accompanied the Mulford Biological Exploration of the Amazon Basin across South America. He must have been unconsciously preparing himself for the position he has held with distinction for the past twenty years. Nearly everyone knows that Dr. Mann is Director of the Zoo, and those who are acquainted with him may have the privilege of seeing the Zoo "under the best auspices"; that is, by touring the Zoo with Dr. Mann himself. Always full of enthusiasm, he is the most entertaining guide to be found in Washington. Now and then he has left the Zoo to direct expeditions for the purpose of collecting and bringing back live animals. He headed the Smithsonian-Chrysler Expedition to East Africa, the National Geographic Expedition to the East Indies, and the Smithsonian-Firestone Expedition to Liberia. And he has made shorter trips to Central and South America.

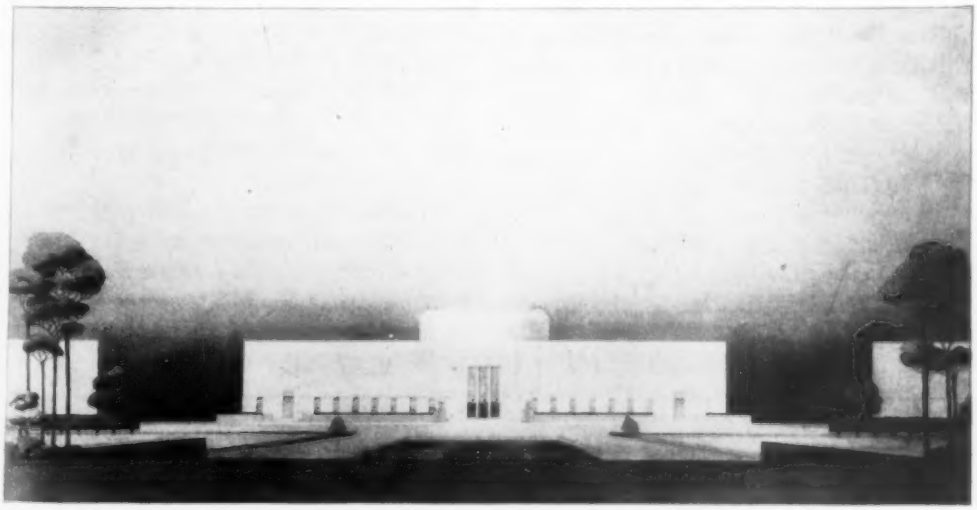
A NATIONAL MUSEUM OF SCIENCE, ENGINEERING AND INDUSTRY

By FRANK A. TAYLOR
CURATOR, DIVISION OF ENGINEERING, U. S. NATIONAL MUSEUM

ONE day the United States will have a national museum of science, engineering, and industry, as most large nations have. Normally, it will be a part of the National Museum under the direction of the Smithsonian Institution and will be based in part upon the present extensive collections of the Smithsonian in these fields. Like all museums of the Smithsonian, this one will be a museum of record as well as of exhibition. As part of the National Museum, its scope will include all the sciences except the natural sciences and all of engineering and industry, including agriculture. In size it will be modest but adequate for many years.

The museum will carry on and extend the activities of the engineering and industrial sections of the National Museum. These began more than 65 years ago as adjuncts of anthropology with the purpose of showing the machines and industrial processes which derive from primitive tools and methods. A few were started to illustrate applications of the natural sciences, such as mining, which came out of geology by way of economic geology.

The early curators had their choice of material from several great expositions and opportunities for personal contacts with the inventors and industry builders of a half-century ago. They also had the advantages of the Smithsonian's close association with the engineering and industrial branches of the Government, including the Geological and the Coast and Geodetic Surveys, the Fish Commission, the Corps of Engineers, the Lighthouse Bureau, and the Patent Office. Several fine collections were started with early



A NATIONAL MUSEUM OF SCIENCE, ENGINEERING AND INDUSTRY
ARCHITECT'S DRAWING OF A SUITABLE BUILDING THAT MIGHT BE LOCATED AT EIGHTH STREET AND INDEPENDENCE AVENUE, WASHINGTON, D. C. DRAWN BY ROBERT JORDAN HARPER, 1932.

scientific instruments, patent models, and machines from these sources. During the 65 years of the activity many new industries came into being and had their golden years of invention and expansion. Within the limits of space and funds, most of these opportunities to select and collect relics of the beginnings and subsequent developments of scientific and industrial progress were made good.

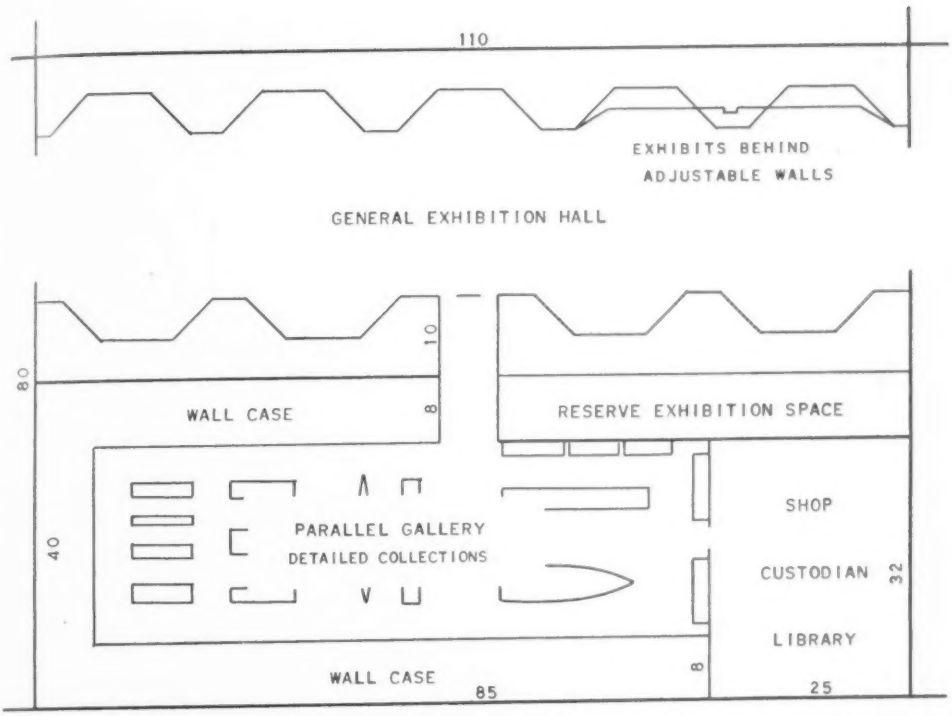
The collections today crowd exhibition and storage space in three buildings of the Smithsonian group and cover (though unevenly) almost the entire scope of engineering, the physical sciences, agriculture, and industry. Engineers, writers, teachers, historians, and inventors make use of the stored and exhibited reference collections, and in spite of a total lack of space in which to set up many worth-while exhibits, a million and a quarter visitors view the collections annually. None of these is adequately served by the present facilities of the museum.

The new museum will continue as a museum of record, to gather the instruments, machines, and papers which mark progress in science, engineering, and industry and preserve them in collections and exhibits for study. In addition it will be a museum of real exhibits which will memorialize the pioneers and venturers and offer instruction in history as well as current information in its fields. The student will continue to find the source materials and the facilities for his studies in the *collections;* the casual or curious visitor will be impressed, entertained, and instructed by the fine *exhibits.*

The plan of museum which seems to offer the most to each class of prospective user of a museum of this type is one form of the parallel gallery plan. It divides the public halls of a museum into an easily traveled route of exhibition spaces for the visitor who comes to look and a system of adjacent parallel halls which are open to all but require some conscious effort on the part of the visitor to enter. The parallel halls are for the detailed material worthy of exhibition but of less than general interest to the crowds of museum visitors. In adopting this plan we discard the step-by-step chronological development of subjects in the general exhibition halls and make no attempt to confine the visitor to a particular route, except to make the way through the exhibition spaces the easiest and most attractive to follow.

Consider as an example the Marine Section—a subject to which entire museums are devoted. We tentatively reserve *nine* exhibition spaces for it. At any particular time these might be devoted to three (more or less) subjects of current information and a half-dozen of historical and technical interest. Current-interest subjects might include exhibits on "The Need for an International Agreement on the Eight-Hour-Day at Sea," "Our Place in the Postwar Maritime Trade," or "The Lakes Ore Carriers." Other exhibits might be "The Annual Manila Galleon," "Small Sailing Craft of New England," "What Was a Clipper Ship?" "The Coal Trade and Coal Schooners," and "The Northwest Passage." Each would tell a complete story presented with a minimum of distracting detail. One might remain on exhibition indefinitely; another might be on for days only.

Exhibits in other sections will be similarly selected, and our museum for the casual visitor will be a succession of such groups. He will find that the easy way to go will be through these exhibits, but nothing will prevent his short-circuiting the tour or digressing into a parallel gallery. The entire purpose is to present to him efficiently a succession of items of more or less general interest, to make it easy for him to select the exhibits he wishes to examine, and, above all, to repay him richly for any attention that he



THE PROPOSED NATIONAL MUSEUM OF SCIENCE, ENGINEERING AND INDUSTRY

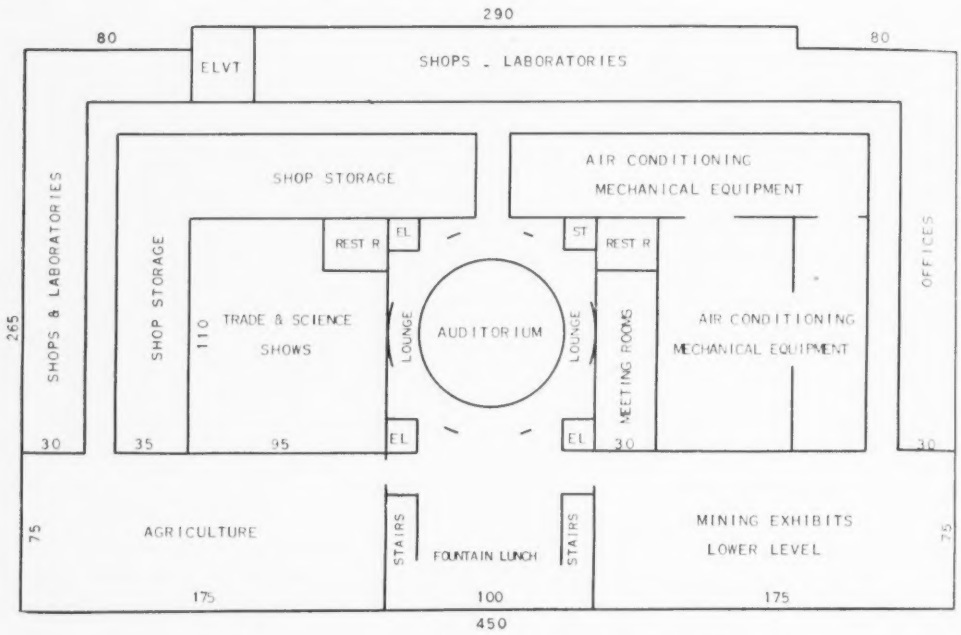
GALLERY PLAN FOR THE MARINE SECTION IN WHICH THE EXHIBITION HALL HAS 30-FOOT CEILING AND THE PARALLEL GALLERY A 15-FOOT CEILING WITH A DECK OVER IT. ATTIC OVER ALL.

gives to a display. In these spaces, the economic, social, and cultural effects of technical and scientific advances will be described from time to time.

The way through the exhibits will be laid out so that the visitor will be little aware of the existence of the parallel galleries. However, if he should become interested in what is in one, he will have to make a turn from the obvious way and pass a large room label which will inform him of what is ahead and urge him to go back to the main track of general exhibits unless he has an interest in the details of the subject ahead. If he goes into the gallery with this warning, he is assumed to have an interest beyond that of the casual visitor and will recognize the material there for what it is without the benefit of emphatic display.

The visitor will find the bulk of the collections in these parallel galleries. Material will be exhibited in them somewhat as it is in the halls of the National Museum today, that is, practically stored behind glass. However, it will be patently stored in the new museum, and the fixtures will be designed both to exhibit their contents and to permit handling of the material under the supervision of an attendant.

To continue the example of the Marine Section, its parallel gallery will contain most of the material that is in the boat hall today. This consists of the scores of contemporary rigged models of sailing and steam vessels, the original builders' models of American vessels beginning in the early 1800's, the display models representing types of vessels important in the development of our maritime affairs and those that represent the work of the pioneer inventors in both sail and steam. Such items as navigating instruments,



BASEMENT PLAN—CEILING HEIGHT, 20 FEET

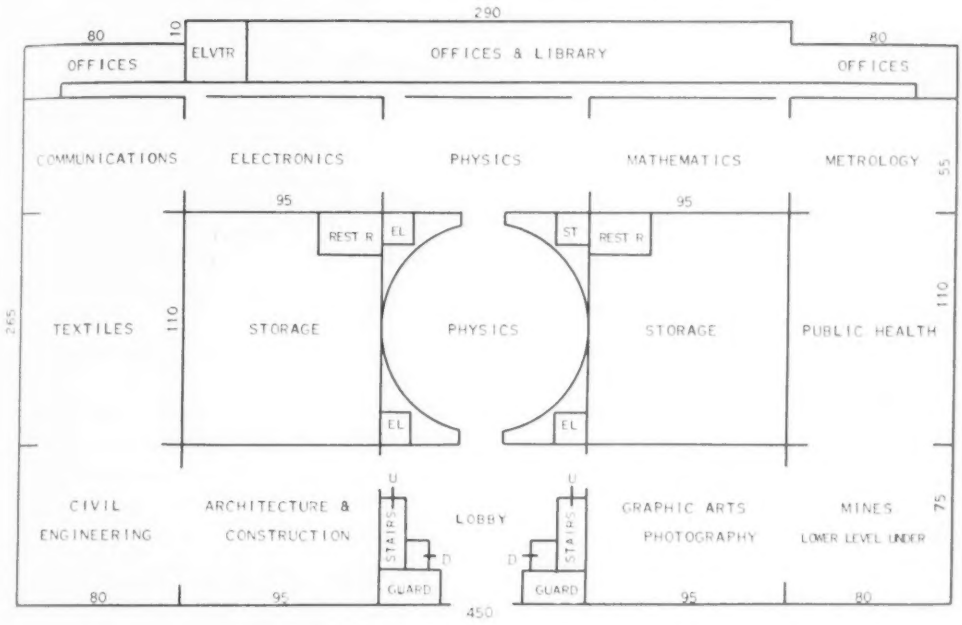
shipbuilding and rigging tools, and full-size and model primitive craft will be included. This material will be exhibited as well as it is now, and some, such as the builders' half-models, would be brought down from the walls to a better viewing position. All will be lighted and readily accessible for removal from cases for closer inspection. The material will be crowded to conserve space, but it will be labeled, organized, and exhibited sufficiently well for the examination of individual items. Comparable material in other sections will be similarly exhibited.

Having such detailed material displayed rather than shut up in office collections serves several purposes. The student can see quickly the breadth and depth of the collection as it relates to his study, a visitor with a special interest can search out many of the details of his subject without help from the staff, and public recognition is given to the accomplishments of the many American scientists, engineers, and industrialists whose work is exhibited in the parallel galleries. If only for the many who come to the museum to poke about, the display of detailed material in the parallel galleries is worth while. Also, this type of display is closely identified with the "Old Smithsonian" museum, and many would regret its elimination.

A THIRD important element of the museum consists of stored study collections or office collections. These contain the very detailed and extensive groups of machines, instruments, patent models, accessories, parts, chemical types and raw materials, drawings, documents, and the sections' libraries and photographic files—to mention only a part. These collections will be under the supervision of the curators and their assistants, who will oversee their use.

The office collections and the material in the cases in the parallel galleries constitute the consultative and record collections of the museum. They will be readily accessible at all times for study.

To sum up the treatment of the collec-



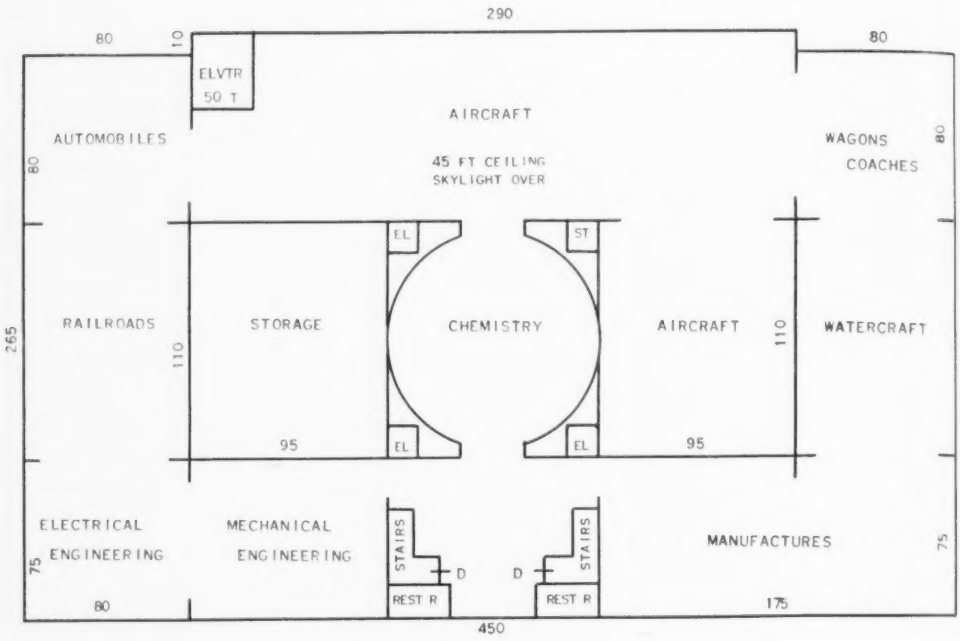
FIRST FLOOR PLAN—CEILING HEIGHT, 20 FEET

tions: The exhibits will be uncrowded spot displays, easily changed and flexible in size, arrangement, and relationship to one another; the parallel halls will contain the material appealing to those with special interests, and the office collections will contain the material not suitable for even limited display, though it may often be the material of most historical or technical interest.

Reference to the plan of the Marine Section will show the development of this plan in one rectangular hall of the proposed building. Exhibition space is located along the interior walls, and the exterior side, with possibilities for windows, is used for the parallel gallery where considerable time will be spent by staff members and students. The room at the end of this particular parallel gallery is a small workshop and library occupied by a staff attendant, who will assist inquirers in the use of the collections. He will remove objects from cases for examination, oversee the use of the office collection material, and, when not otherwise employed, repair and maintain the collections. The workshop space will have one gallery for bookshelves, which will connect with a storage deck over the reference exhibit hall and also with the attic space over all.

In the space reserved for the general exhibits, the fronts of the individual exhibition spaces form the side walls of the exhibition hall. They will be constructed of panels on a number of module dimensions which can be combined to vary the walls to form shallow and deep alcoves. These panels in turn will be made with a variety of apertures which will look into enclosures of different depths up to rooms 10 feet by 12 feet. Obviously, space will be wasted when flush or shallow enclosures are used, but this is justified by the economy of effort in changing displays. This plan is generally adaptable to all subjects and sections.

This leaves size to be considered, and determining the size of a museum is an essentially arbitrary procedure. There is no limit to the possible development of



SECOND FLOOR PLAN

CEILING HEIGHT, 30 FEET, WITH ATTIC OVER ALL EXCEPT FOR SKYLIGHT OVER THE AIRCRAFT EXHIBIT.

a museum with the broad scope of this one. Almost any section could be expanded into a substantial museum with valid justification. For example, the Congress received and passed a bill to authorize the National Air Museum as a bureau of the Smithsonian Institution while this article was being written. Some staggering ideas as to the size and scope of that museum have been ventured. One calls for a vast collection containing examples of every type of airplane, engine, instrument, part, and accessory that can be procured, requiring $2\frac{1}{2}$ to 3 million square feet of space. Assuming such a collection is made, there is the question of its practical relationship to a public museum. Only a tiny fraction of it could be seen by the thousands of people who would be attracted to it. The collection might be housed and operated more efficiently as a research "library" of machines, separate from the functions of public display and commemoration. If so, the space set aside in our plan might still be sufficient for the public activities of the National Air Museum. Anyway, we have left it in as a fine example of the spread of ideas about size.

The building we propose is a rectangular one 450 feet long by 275 feet deep to fit the area between Independence and Maryland Avenues and Seventh and Ninth Streets facing the Mall in Washington. This lies between two triangular areas which are looked upon as the space into which to expand the museum when necessary. The building is a three-storied one, entered on the first, or ground, floor with a basement below and the main floor above. All three floors will be used for exhibition spaces and parallel galleries. An "attic" extends over much of the top floor. The building is as plain as is appropriate for its neighborhood. The halls are few in number but large in size and rectangular or square in shape. The maximum use of false walls and decks will be made to

adapt a room to its contents. A plentiful supply of underfloor service channels and movable exhibition space fronts is expected to make it easy to fit the rooms to the collections. Each room will be divided into exhibition space and parallel galleries as required.

In considering size it will be seen that the Marine Section is housed in a space 80 feet by 110 feet, part of it two stories high with an attic over all. The parallel gallery alone is as large as the exhibition space now devoted to these collections, and the storage space is a complete gain. It is believed that this amount of space would continue to accommodate this section for an indefinite period of time much more efficiently than it is housed now. Similarly, the space allotted to other sections is two to three times greater than now occupied.

It is expected that a tour of the exhibition spaces in all halls would require about two hours at a pretty fast rate of inspection. This, unfortunately, is more than twice as much time as the average visitor allows himself or is allowed by his sightseeing tour or guide. If this condition continues—and it probably will—this amount of general exhibition space will be adequate indefinitely. Given a considerable number of striking displays, there can be little objection to some crowding of the bulk of the exhibited collections in the parallel halls. This means a great economy of space as compared with the present showing of material combining both exhibition and public storage. As little proper storage space is now available to these sections, the large volume of storage space in the plan makes it infinitely adequate from that point of view. Barring changes in scope and policies, the proposed museum can be expected to serve all the functions of the museum of its type indefinitely.

FRANK A. TAYLOR

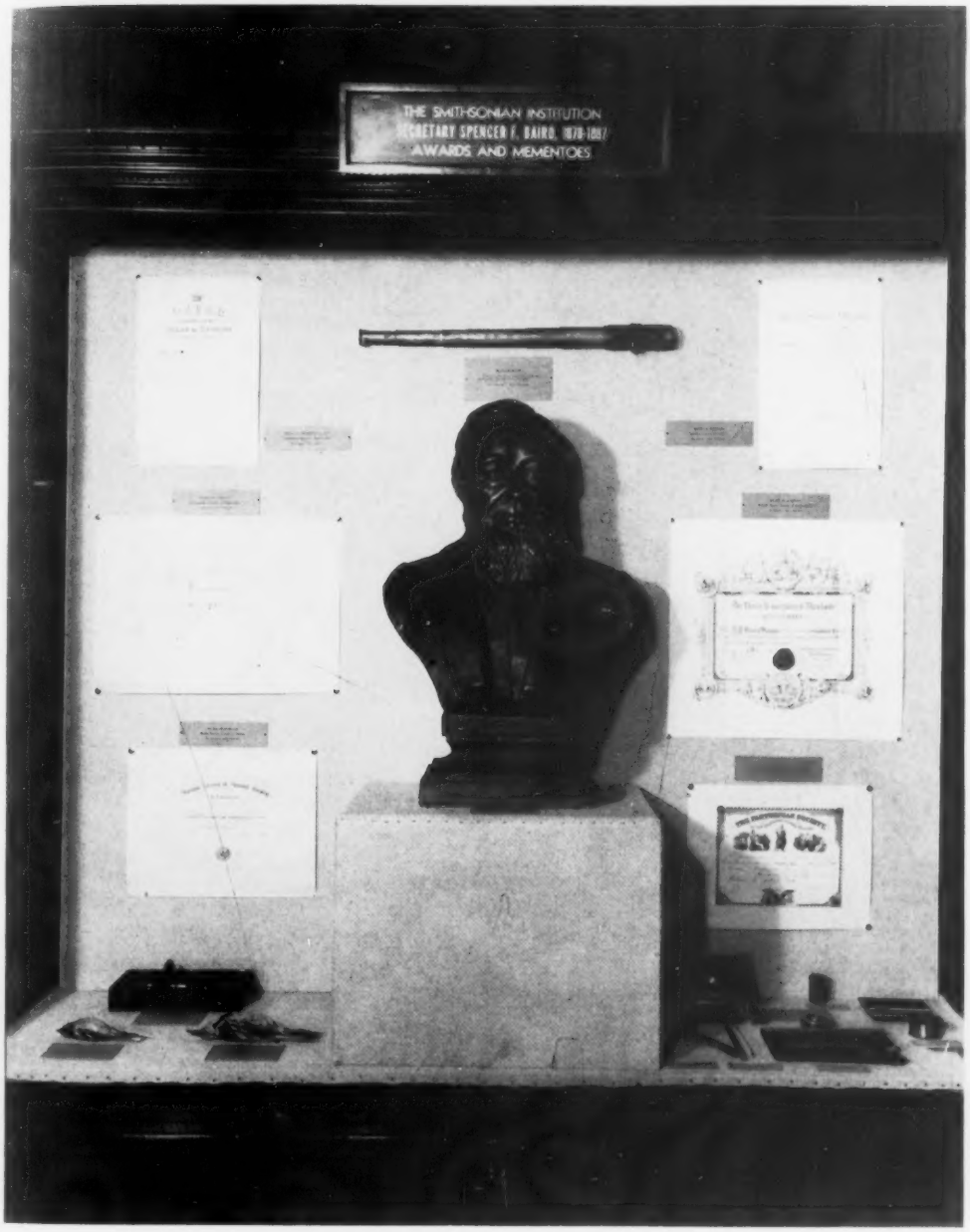
FRANK A. TAYLOR, B.S., LL.B., is a moderately old hand at the museum business. In a quarter-century (less a few months) with the National Museum he has worked through the museum routine of modelmaking, preparation of exhibits, collecting and preservation, research and writing—all in the field of the history of engineering and related museum activities. An occasional time out was taken to acquire a B.S. in mechanical engineering (M.I.T.), for a considerably less than "grand tour" of the European technical museums (1926), a short turn at teaching (Catholic University), for a law degree (Georgetown), to act as associate director of Federal Works Project No. 6, "The Historic American Merchant Marine Survey," (W.P.A.), and to command an antiaircraft gun unit in the south and west Pacific (A.U.S.). Mr. Taylor is a member of the American Society of Mechanical Engineers and of the Ship Model Society of Washington, D. C.

THE SECRETARIAL CASES*

By THEODORE T. BELOTE
CURATOR, DIVISION OF HISTORY, U. S. NATIONAL MUSEUM

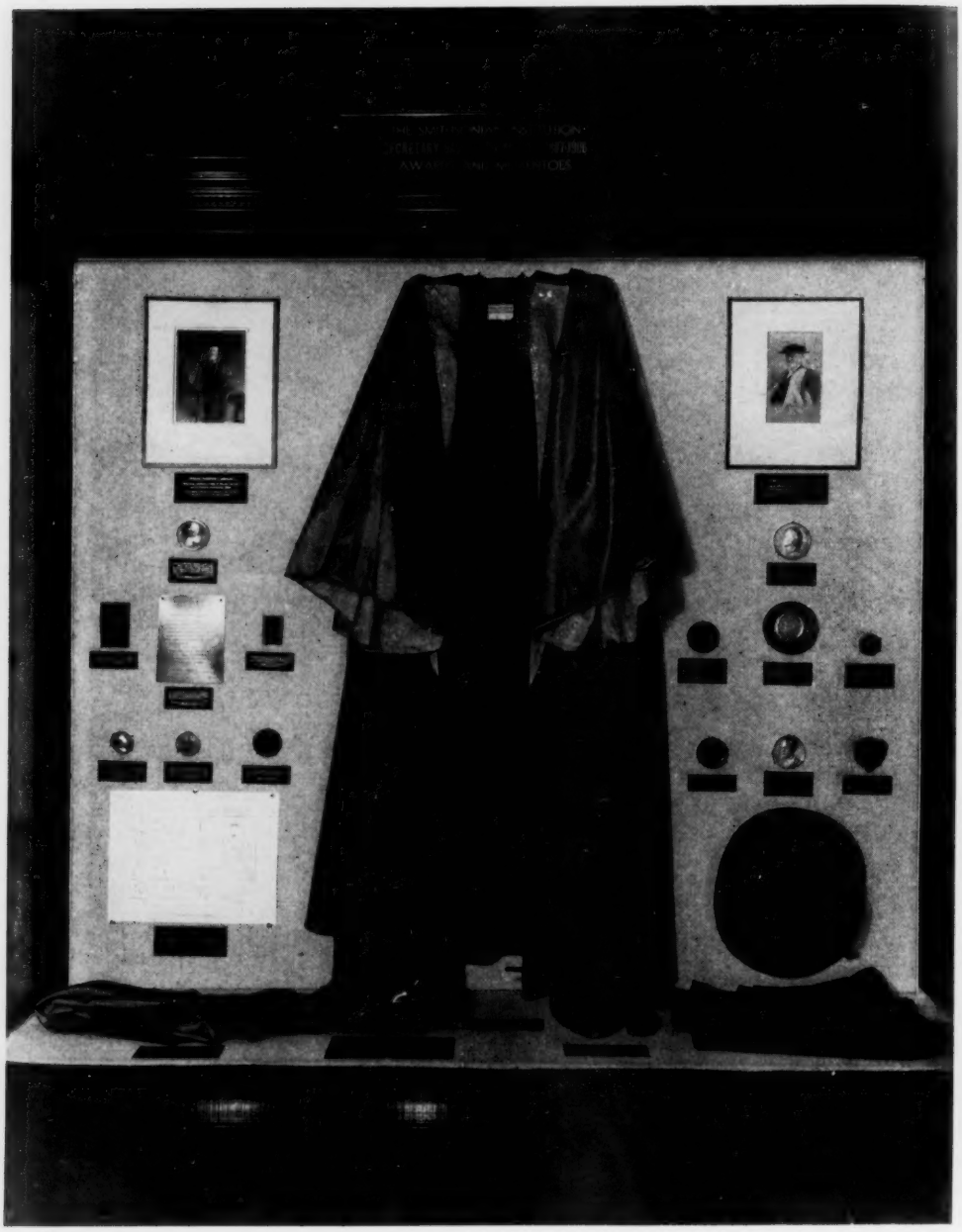
As a part of the present temporary exhibition of museum materials in connection with the commemoration of the centennial anniversary of the founding of the Smithsonian Institution, a series of four large cases containing objects of personal and scientific interest in the careers of the first four secretaries of the Smithsonian Institution has been installed in the main hall of the original Smithsonian Building. The contents of these cases illustrate in chronological order the work of the distinguished scien-

* Owing to lack of space, photographs of only one of the two sides of these exhibition cases are here published.—Ed.



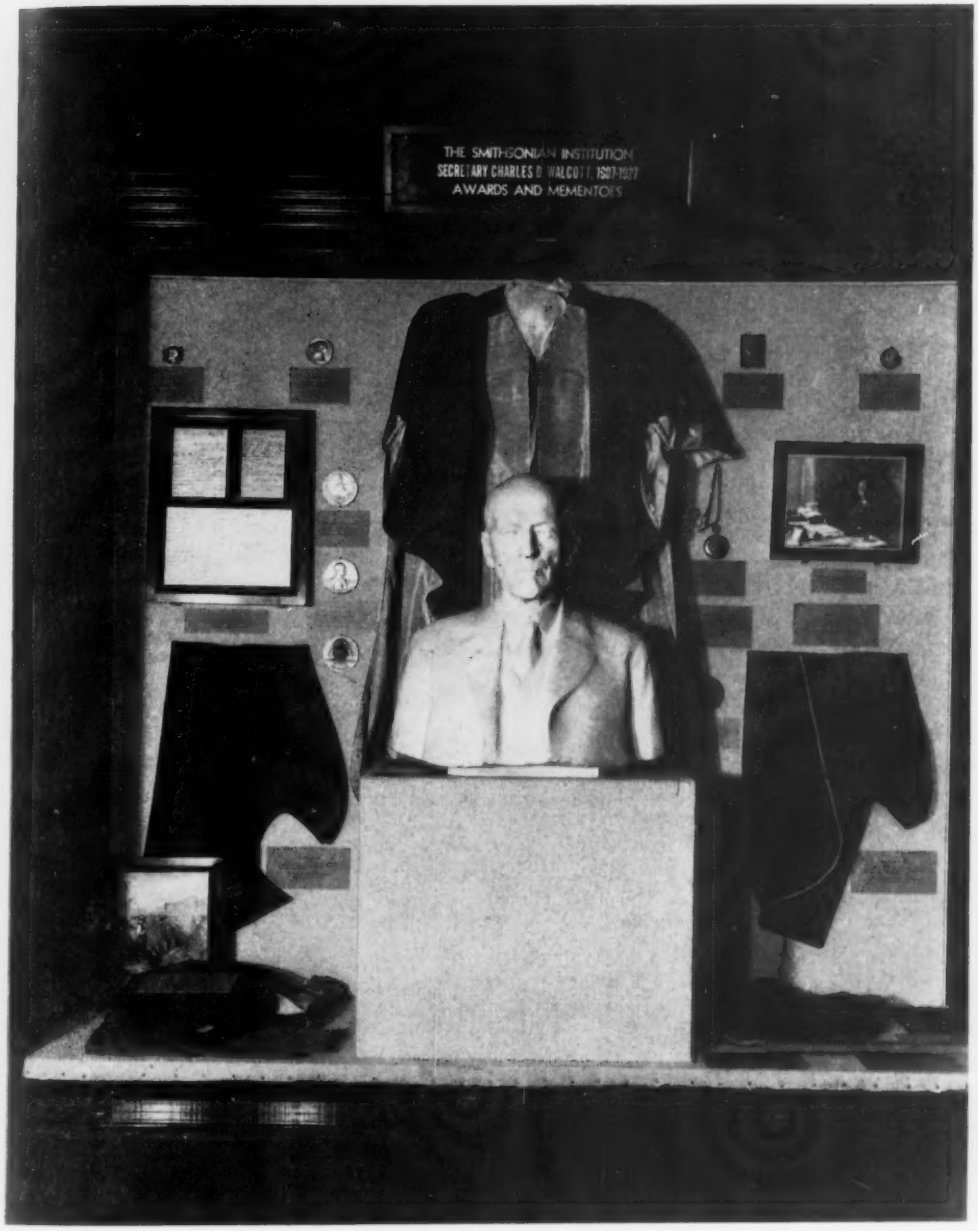
tists who served as secretaries of the Smithsonian Institution from 1846 to 1927: Joseph Henry, 1846–1878; Spencer F. Baird, 1878–1887; Samuel P. Langley, 1887–1906; and Charles D. Walcott, 1907–1927.

The case representing the career of Joseph Henry, Secretary of the Smithsonian, 1846–1878, contains a model of the electric magnet made by him for the Yale College laboratory in 1831 and various small pieces of apparatus used by him in his physical experiments. The objects of personal interest shown in the



case include water-color portraits of Joseph Henry and his mother; the first scientific book used by him; the order of Saint Olaf awarded him in 1870 by the King of Sweden and Norway; gold, silver, and bronze medals presented to him; diplomas and certificates of membership in various scientific societies; and various other mementos of his career.

The case representing the career of Spencer F. Baird, Secretary of the Smithsonian, 1878–1887, contains specimens of birds collected by him when a youth, a field glass and some of the scien-



tific instruments used by him in his work as a naturalist. The objects of personal interest in this case include a plaster bust of Secretary Baird, a letter written by him, one silver and two gold medals, and diplomas and certificates of membership in various scientific societies awarded him in recognition of his scientific achievements.

The case representing the career of Samuel P. Langley, Secretary of the Smithsonian, 1887–1906, contains various pieces of apparatus used by Secretary Langley in his experiments in

physics and aeronautics. These include a bolometer, a telephoto camera, and a revolving sector photometer. The objects of personal interest in this case include two water-color portraits of Secretary Langley, a number of gold medals, and pieces of academic costume worn by him when he received honorary degrees from American and foreign universities. With these objects are shown four of his scientific publications.

The case representing the career of Charles D. Walcott, Secretary of the Smithsonian, 1907–1927, contains examples of the trilobites collected by him in his work as a geologist, his appointment as Director of the Geological Survey in 1894, and the letter written by him to Chief Justice Melville W. Fuller accepting the appointment as Secretary of the Smithsonian. With these objects are shown several gold medals awarded to Dr. Walcott in recognition of his work as a geologist, diplomas representing honorary degrees from American and foreign universities, and various pieces of academic costume worn by him at the time of his acceptance of these degrees. In this case are also shown a marble bust of Secretary Walcott and a gold watch and chain worn by him for a long period.

The four cases just described contain a collection of materials which illustrate in a striking manner the personalities and the individual achievements of the four secretaries of the Smithsonian Institution represented by these exhibits. They also represent some of the important phases of the scientific work of the Smithsonian during the period of their administration, 1846–1927. The present location of the cases in the original Smithsonian Building is ideal from the viewpoint of historical significance.

THEODORE T. BELOTE

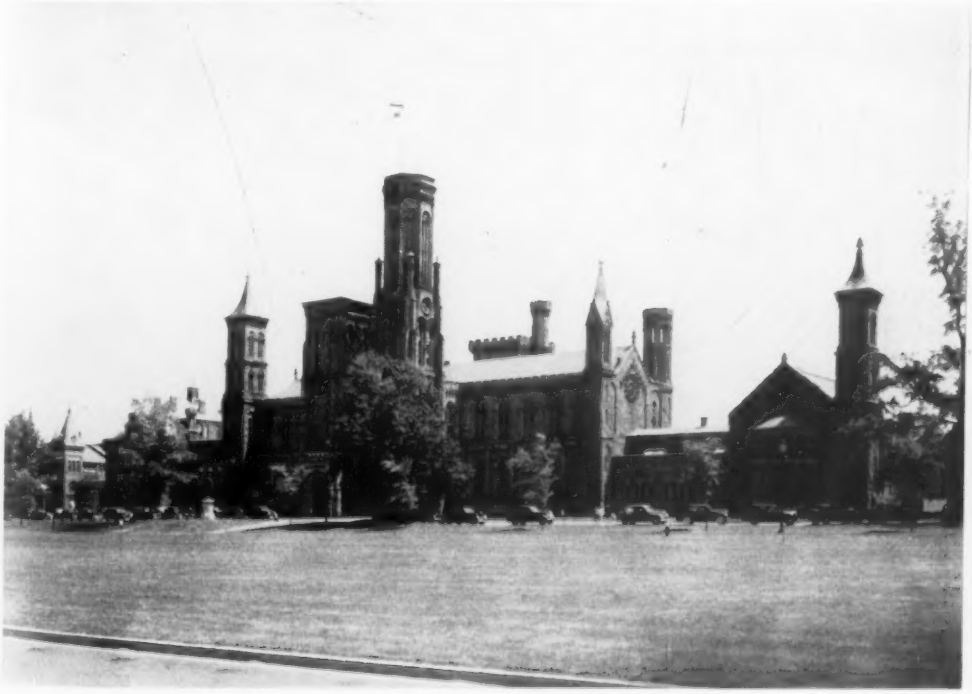
THEODORE T. BELOTE, A.M., has been Curator of History, U. S. National Museum, since 1908. His Division of History "administers not only the great collections of civil, military, and naval historical material, but also coins, medals, and stamps." Mr. Belote was born in Bridgetown, Va., on May 3, 1881. He graduated from Richmond College (Va.) in 1902 and for the next six years pursued graduate work in history at the following institutions: Richmond College, University of Berlin, Harvard University, University of Cincinnati, and the University of Leipzig. At the end of his second year in Germany he was appointed to his present position. At the University of Cincinnati (1906–07) he was Colonial Dames Fellow in Ohio Valley History. He is the author of "The Scioto Speculation and the French Settlement at Gallipolis," 1907; "American and European Swords in the Historical Collections of the United States National Museum," and various essays on historical museum subjects.

THE DIVISION OF RADIATION AND ORGANISMS: ITS ORIGIN AND SCOPE

By EARL S. JOHNSTON

ASSISTANT DIRECTOR, DIVISION OF RADIATION AND ORGANISMS, ASTROPHYSICAL OBSERVATORY

In 1895 Dr. Charles Greeley Abbot was appointed as an aid in the Astrophysical Observatory. This branch of the Smithsonian Institution had been established by Secretary Samuel Pierpont Langley for the purpose of investigating the energy of the sun and the distribution of its radiation in the spectrum. Upon the death of Secretary Langley in 1906, Dr. Abbot was made Director of the Observatory, and his interests grew from the mere measurements of solar radiation to the effects this radiation has on the flora and fauna of the earth, on the weather, and on mankind in general. During a voyage to Australia in 1914, he discussed extensively with Dr. Lyman J. Briggs, who later became Director of the National Bureau of Standards, the subject of photosynthesis, the basic reaction in green plants upon which all life depends. It is not surprising that shortly after he became Secretary of the Smithsonian Institution on January 10, 1928, he set about to put into reality some of his earlier dreams of important lines of research.



GENERAL VIEW OF THE SMITHSONIAN BUILDING

THE OFFICES OF THE DIVISION OF RADIATION AND ORGANISMS ARE LOCATED IN THE FLAG TOWER AND ITS LABORATORIES ARE IN THE BASEMENT OF THE WEST WING (ON THE RIGHT).

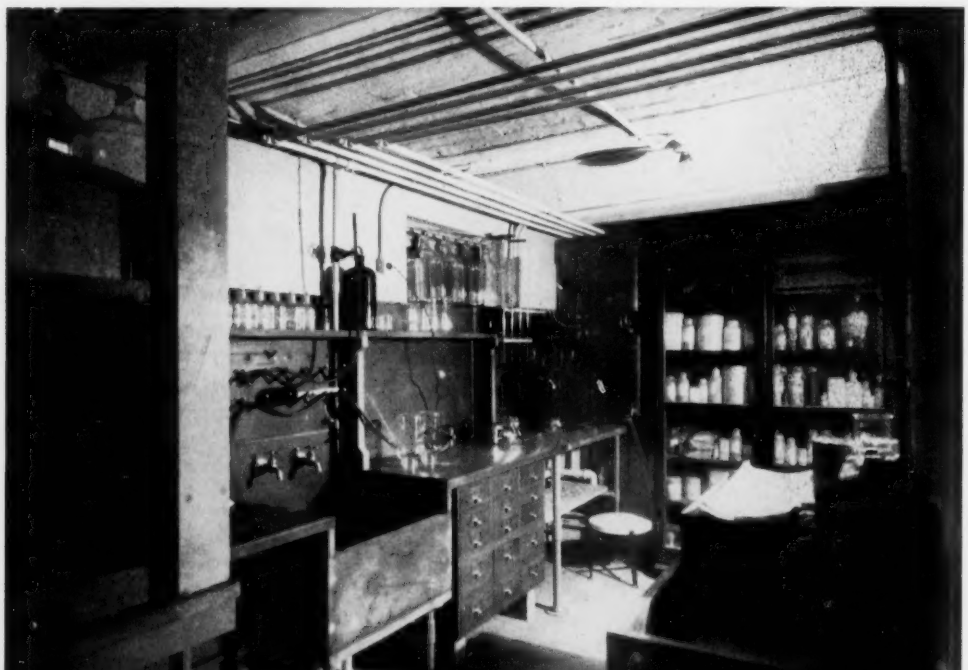
In a letter dated February 11, 1928, to Colonel Isaac N. Lewis, Dr. Abbot wrote:

> In order that, as you requested, some minute of our conversation of February 9 should be preserved, I am sending you a short summary of the work in radiation which I am hoping to undertake.
>
> Of course, as Uncle Joe Cannon said, "Everything hangs upon the sun"—the weather, the growth of plants, the health of man and animals. For many years the Smithsonian Institution has been measuring, at selected cloudless stations, the intensity of the solar rays. . . . This quantity, expressed in appropriate units, is called the "solar constant of radiation." . . . From these studies of the intensity of the sun's radiation which have gone on now a good many years, there are three important branches which, as yet, we have scarcely explored at all. They are: First, the relation of solar radiation to the growth of plants; second, the effects of solar radiation on the health and growth of animals and human beings; and third, the dependence of world weather on solar radiation.

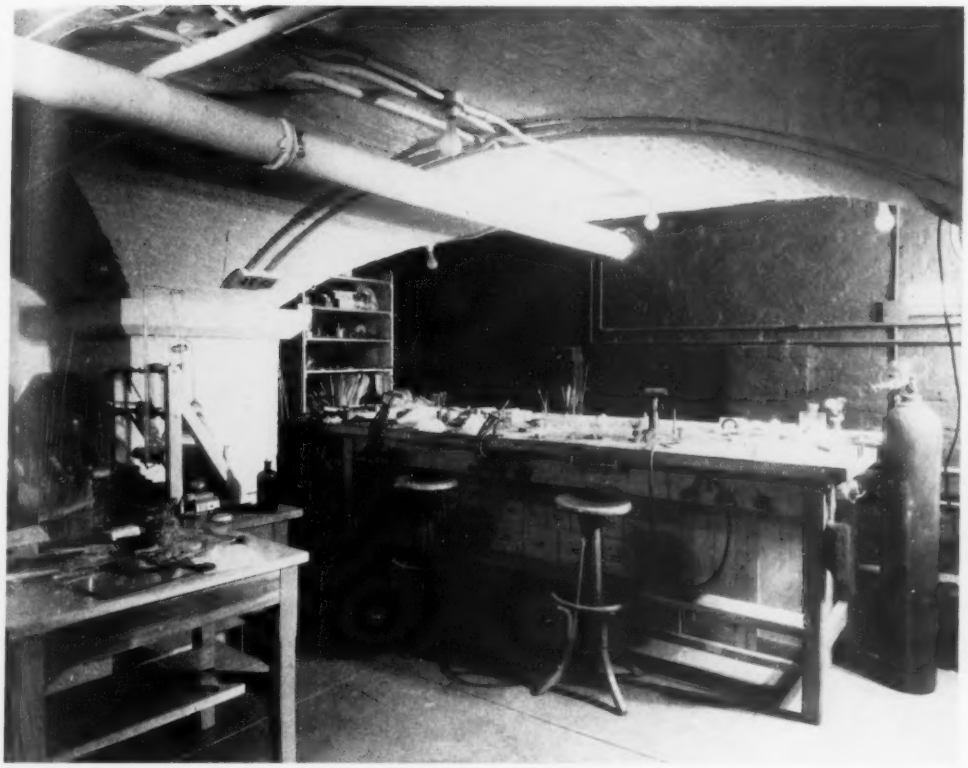
Dr. Abbot had particularly wished for many years to undertake the first abovementioned branch, namely, the relation of solar radiation to the growth of plants. The Astrophysical Observatory had acquired much experience in the measurement of radiation and of heat and had a collection of large pieces of optical apparatus which, when combined, comprised a unique preparation for research on the relation of radiation to life. He was successful in obtaining financial support from the Research Corporation and announced in the annual report of the Smithsonian Institution:

> It is therefore with unusual satisfaction that I record the establishment on May 1, 1929, of the Division of Radiation and Organisms.
>
> The purpose of this division is to undertake those investigations of, or directly related to, living organisms wherein radiation enters as an important factor.

In this manner the Smithsonian Insti-



VIEW OF A SECTION OF THE CHEMICAL LABORATORY



GLASSBLOWER'S BENCH

SPECIAL GLASS APPARATUS AND SENSITIVE LIGHT MEASURING INSTRUMENTS ARE CONSTRUCTED HERE.

tution's youngest unit, the Division of Radiation and Organisms, came into being. An elevator was installed and offices built and furnished in the North, or Flag, Tower of the Smithsonian Building. The basement of the west wing, used previously for storage, was renovated and equipped for laboratory purposes. This laboratory space was ideally suited for the purposes desired. The thick walls of its partly underground rooms insured an evenness of temperature; daylight could easily be excluded in rooms where artificial illumination was to be employed. The original personnel staff under Dr. Abbot's direction consisted of: F. S. Brackett, Research Associate in Charge; Earl S. Johnston, Consulting Plant Physiologist; L. B. Clark, Research Assistant; and Virginia P. Stanley, Stenographer and Laboratory Assistant. During the early development of the Division close cooperation was maintained with the Fixed Nitrogen Laboratory and other bureaus of the Department of Agriculture and with the University of Maryland. It greatly benefited by the advice and cooperation of Dr. F. G. Cottrell and Dr. W. T. Swingle.

The original program of investigations fell into two main divisions:

I. Direct investigation upon living organisms.
II. Fundamental investigations related to biological problems.
  1. Molecular structure investigations.
  2. Photochemical investigations.

From the beginning most of the research has concerned itself with direct investigation upon living organisms, and with few exceptions this work has been carried out on physical problems having a direct bearing on biological investiga-

A PORTION OF THE MACHINE SHOP

tions. A large proportion of this work has depended upon the ingenious designing and construction of original apparatus in the Division's shops.

Extremely close relationship had always existed between the Astrophysical Observatory and the Division of Radiation and Organisms. Frequently, common use was made of its apparatus, shop equipment, and personnel. With the growth and development of the Division it became financially more and more difficult to support it from the private funds of the Institution, so that as of July 1, 1941, its members were given Civil Service status and its work was then carried on from appropriations allotted to the Astrophysical Observatory. The work of the Astrophysical Observatory is now carried on by its two divisions, Astrophysical Research and Radiation and Organisms.

A large proportion of the research carried on by the Division of Radiation and Organisms has been distinctly fundamental in nature. The counsel of its members has been sought constantly on technical and research problems in the field of radiation and its relationship to living organisms. During the period of World War II its regular work was suspended in order that its staff members could devote their time to some of the immediate needs of the day. This work dealt mainly with problems of deterioration of cloth, cardboard, and electrical wire insulation by molds and by ultraviolet light. Other work was related to emergency rescue equipment dealing with the production of potable water from sea water by chemical methods and solar distillation. The termination of this emergency work permitted the resumption of the Division's regular re-

search program. At present this program is focused on problems dealing directly or indirectly with photosynthesis, respiration, and factors influencing plant growth, with special emphasis on wave-length effects of radiation.

SPACE does not permit more than a mere mention or brief discussion of the Division's work. It should be pointed out at this time that in most of the research involving the measurement of radiation these measurements have been made by means of a vacuum thermocouple of extremely high sensitivity, designed and constructed by Mr. L. B. Clark, a member of the Division since its origin. This couple is made of three-part alloy wires, drawn down to a very small diameter and for some purposes etched to 4 to 5 μ diameter. It is remarkably sturdy. Because of its excellent characteristics, this couple has been in great demand in other laboratories throughout the country.

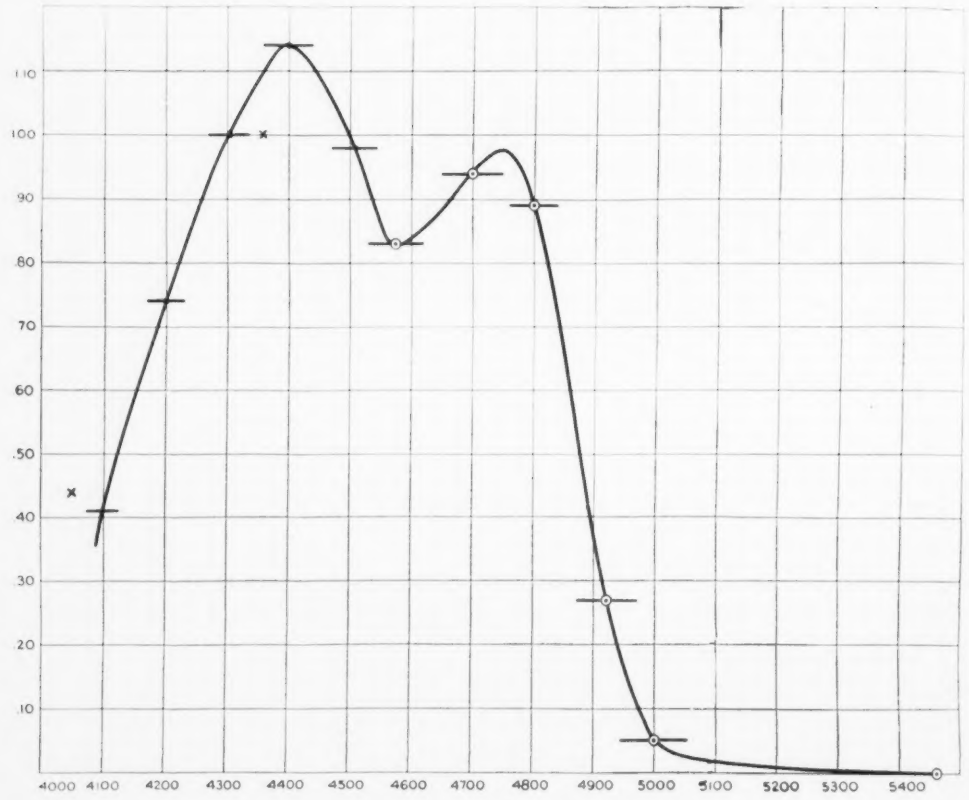
One of the most commonly observed responses of plants to light is phototropism. A potted plant growing in a well-lighted window soon grows toward the light and, unless it is turned frequently, a marked lopsided growth results. Many other examples could be given of plants bending toward light. One of the early problems undertaken by the Division was to study the wave-length effect of light on this specific type of plant growth. Would the bending take place equally well in red light and in blue light? Or is the plant sensitive to one color and not to another?

The general procedure used in studying the wave-length effects in phototropism was to place an oat seedling between two different lights. After a time interval the seedling was examined for a one-sided growth. If, for example, when the seedling was exposed to blue light on one side and to green on the other, a distinct bending was noted toward the blue light, it was then known that the blue light exerted a greater retarding action, since the side of the seedling toward the green light grew more, thus bending the seedling toward the blue light. The lights were then so adjusted as to increase the green or decrease the blue intensity. Another seedling was used and the process repeated until a balance point was obtained where the effect of one light neutralized the effect of the other. When this point was determined a specially constructed thermocouple replaced the seedling and by means of a galvanometer the light intensities were measured.

From many such experiments in which seedlings were grown between lights of different colors, a wave-length sensitivity curve, or action spectrum of phototropism, was constructed. In this curve the sensitivity of the oat coleoptile was plotted vertically and the wave length of light plotted horizontally. The sensitivity increases rapidly from 4100A to 4400A, then falls off somewhat to about 4575A, and again rises to a secondary maximum at about 4750A. From this point the sensitivity decreases rapidly to 5000A, from which point it gradually tapers to 5461A, the threshold of sensitivity on the long wave-length side. Briefly, it can be concluded that the region of greatest sensitivity is in the blue; that is, growth is retarded most in blue light. Orange and red light have no effect in retarding this particular type of growth.

A marked effect of temperature upon the growth inhibition of the oat coleoptile by light has been observed. Below 25° C. the inhibition is independent of temperature; between 25° and 30° the inhibition effect becomes smaller as the temperature increases; above 30° there is no inhibition and possibly a slight stimulation by light. These findings apply, of course, only to the specific conditions of intensity and wave length which have been studied.

Light to be effective in this and other



PHOTOTROPIC SENSITIVITY CURVE

THE RELATIVE SENSITIVITY VALUES ARE PLOTTED VERTICALLY AND THE WAVE LENGTHS, IN ANGSTROMS, HORIZONTALLY. THE HORIZONTAL BARS INDICATE THE WAVE-LENGTH RANGES AT THE BALANCE POINTS. CIRCLES INDICATE POINTS OBTAINED WITH FILTERS COMBINED WITH THE MONOCHROMATOR. POINTS MARKED X INDICATE THE USE OF MERCURY LINES.

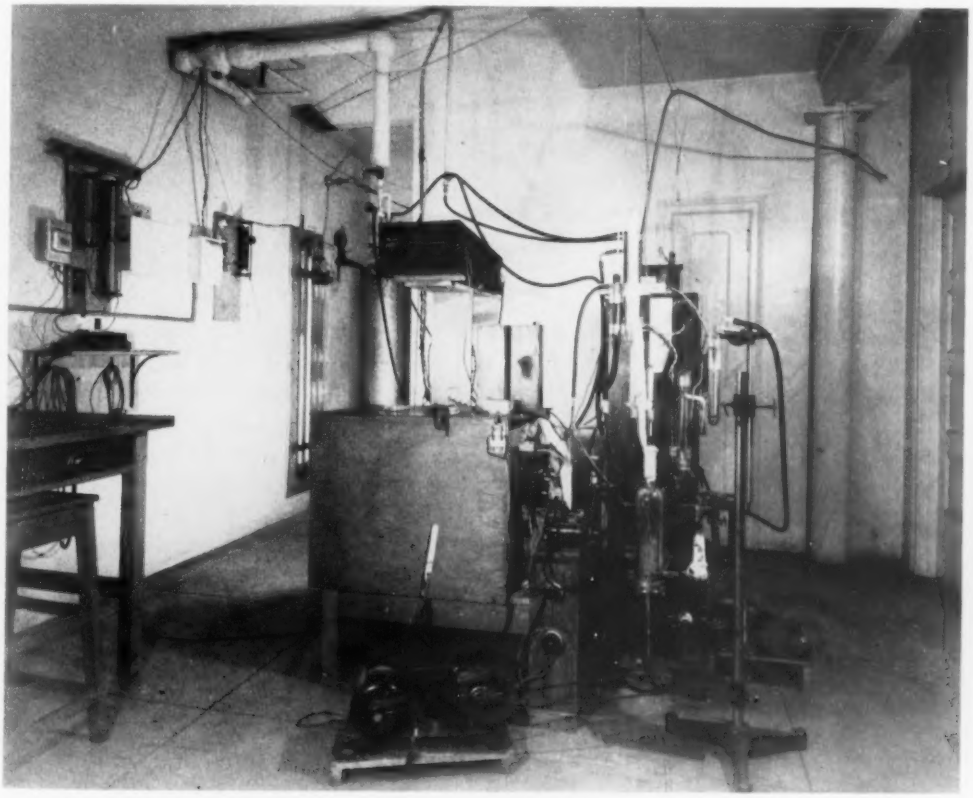
reactions must be absorbed. This postulates the presence of light-absorbing substances. It is interesting to note that attention has been called to the similarity of the carotene absorption curves to those of the action spectrum of phototropism. Other investigations indicate that phototropism is associated with auxin, or growth substances, found in plants, and considerable work as to the effect of wave lengths on these materials has been continued. Light in some manner inactivates the auxins on the illuminated side or it causes them to migrate to the shaded side or perhaps does both, thus resulting in a greater cell elongation on the shaded side. In addition to the effects of radiation itself other environmental factors such as temperature, mineral nutrition, and aeration have been studied. Additional data have been obtained regarding the action spectrum of mesocotyl inhibition in oats over a wide range of light intensities. At low intensities a maximum occurs at 6600A and a second maximum in the neighborhood of 6200A. Comparisons have been made of the effectiveness of red and of violet light for several other species representing a majority of the tribes of grasses. The response to all species have been found to be fairly similar to that of *Avena*.

A very interesting effect of light upon root growth has been noted. Roots caused by mechanical restraint to grow

in a horizontal direction elongate at their normal rate in darkness, but are greatly inhibited by light. In addition to the interest in the mechanism by which this result might be caused, it is noted that red light is effective, indicating the presence of a pigment which absorbs these wave lengths.

Just as certain wave lengths of light may accelerate certain growth processes and others retard them, there are some that are harmful and even lethal. In a series of experiments the lethal sensitivity and speed of effectiveness in killing of ultraviolet radiation was studied. Cultures of green algae (*Chlorella vulgaris*) were grown on glass plates covered with agar. These plates were placed in special holders and exposed to the spectral lines of a quartz mercury-vapor lamp. The intensities of these different lines, ranging from 2250A to 3022A, were carefully measured and their effects on the algae noted. The lethal action was easily detected. Where such radiation fell on the plate the dead algae stood out in sharp contrast with the living. From careful measurements of plate densities and correlation of these data with wave-length intensities and durations of exposure, the radiotoxic spectral sensitivity was calculated.

For this and other work in which the effects of illumination on growth and metabolism are quantitatively studied, it is necessary to record accurately the intensities and to know the characteristics and limitations of the radiation involved. Hence, a considerable amount of the Division's research has been in the field

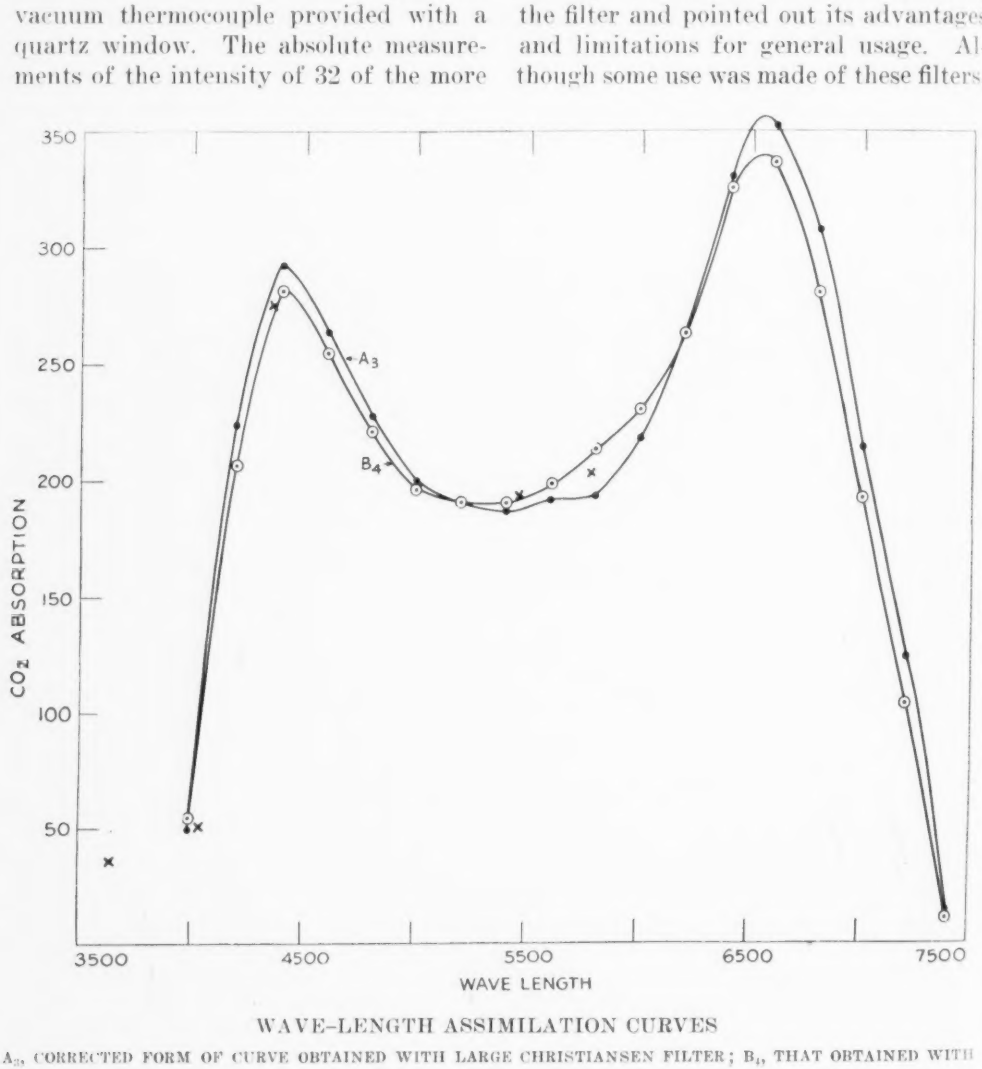


SPECIAL EQUIPMENT

USED FOR THE SPECTROGRAPHIC DETERMINATION OF MINUTE QUANTITIES OF CARBON DIOXIDE.

of physics. For example, an absolute measure of the energy in the lines of the mercury-arc spectrum was needed in greater detail than was available in the literature at that time. Measurements were made on five different Cooper-Hewitt 220-volt D.C. quartz arcs, covering the region 2100A to 7000A. Two Bausch & Lomb quartz monochromators were used singly and also in tandem as a double monochromator. The observations were made with a single-junction vacuum thermocouple provided with a quartz window. The absolute measurements of the intensity of 32 of the more intense lines in the visible and ultraviolet spectrum of the quartz mercury arc were made and the results published.

The problem of securing monochromatic light of high intensity is one that continually confronts the physiologist dealing with light-growth responses. The possibility of using the Christiansen light filter was thoroughly investigated and reported in published form. This excursion into physical optics set forth an improvement in the construction of the filter and pointed out its advantages and limitations for general usage. Although some use was made of these filters,



WAVE-LENGTH ASSIMILATION CURVES

A_3, CORRECTED FORM OF CURVE OBTAINED WITH LARGE CHRISTIANSEN FILTER; B_4, THAT OBTAINED WITH SMALL CHRISTIANSEN FILTERS. X POINTS OBTAINED WITH LINE FILTER AND QUARTZ MERCURY ARC.

the problem of obtaining a high intensity monochromatic light still remains unanswered for many practical purposes.

In much of the earlier quantitative investigations on photosynthesis, algae were used as test plants. In the Division's laboratories new techniques for studying this vital subject were devised and applied to higher plants such as wheat seedlings. The plants were grown under controlled artificial conditions and the carbon-dioxide determinations made by a conductivity method in which this gas was completely absorbed in a standard KOH solution. Later, an infrared spectrographic method for the determination of carbon dioxide was developed. This method is unique for its speed and sensitivity and has the additional merits of being independent of water vapor and of having but small pressure and temperature corrections. Furthermore, the air can be circulated continuously over the plants without any loss in the process of analysis. The method has been further improved by the addition of a photographic recorder. The sensitivity at normal air concentration is in the neighborhood of 1 part CO_2 to 1,000,000 parts of air. Without any great loss in sensitivity, measurements may be made in a fraction of a second.

Data obtained from one set of experiments showed the assimilation of carbon dioxide by young wheat plants over a wide range of carbon-dioxide concentrations and light intensities. Linear variation of assimilation with carbon-dioxide concentration in the presence of excess light was observed over a limited range. Linear variation of carbon-dioxide assimilation as a function of light intensity for excess carbon-dioxide concentration was also observed over a limited range. The transition range between the two regions of limiting factors was more extensive in these plants than in algae.

In another series of experiments the rate of photosynthesis based on equal incident energy was determined as a function of the wave length of light for young wheat plants. From this work it was concluded that the entire visible spectrum is effective in photosynthesis. Although not accurately determined, the wave-length limits appear to be between 7200A and 7500A on the long wave-length end of the spectrum and less than 3650A on the short wave-length end. There appears to be a principal maximum at 6550A in the red and a secondary maximum at 4400A in the blue. Increased reflection and transmission of radiation in the green region by the leaves of the plants diminished the effectiveness of light in this region to promote photosynthesis.

By making use of the spectrographic method of determining carbon dioxide a most important series of experiments was carried out. It was demonstrated that much of the previous work on the time course of photosynthesis with algae was verified with young wheat plants. It was also shown that in flashing light a minimum of carbon-dioxide assimilation was found between 15-second periods and continuous light, with an increase in assimilation efficiency with increased frequency of intermittency. Emphasis should be placed on the importance of other studies of the induction period as a method of obtaining further information on the mechanism of photosynthesis.

PERHAPS the best way to summarize the activities of a research organization and obtain an idea of the field covered in its work is to examine its publications. Here are set down the results of its work. However, such an examination is like examining a seed. It is impossible to judge the size of the harvest from the size of a seed. Undoubtedly some seeds will yield fruit whereas others will not. A true estimate cannot be made until the

end of time, for, like seeds, one piece of scientific research begets another. Nevertheless, some information as to the general trend or direction the research of the Division of Radiation and Organisms has taken may be obtained from the titles of its publications. Such a list is rather long, but a few of the more important articles have been appended to this brief article.

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THE HUMAN BLOOD FLUKES

By PAUL BARTSCH

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MUCH has been written on the "blood flukes," most of it scattered through medical journals. This little paper is an effort to bring up to date in an abbreviated form the information now available and to present this in nontechnical language to render it available to the interested general reader.

How important to humanity these parasites are is well illustrated by Faust's statement that in China alone 100,000,000 persons may be afflicted with schistosomiasis,[1] and that is only a little part of the world infested with schistosomes.

Science as a rule progresses with a slow and steady pace, adding increment to increment to produce the results apparent at any period. Now and then, however, stresses and strains like our recent war change the slow pace to saltations, and this has been the case in our understanding of the maladies known as schistosomiasis.

It would be interesting to have an exhaustive historical research on this topic; it might reveal the presence of the malady at the cradle of our civilization in the valley of the Nile. Yea, it seems even likely that the malady existed prior to man's existence and that he then, as now, became simply one of many mammals afflicted with this plague. That this is not an idle dream is indicated by Ruffer's[2] finding of calcified eggs of *Schistosoma hematobium* in mummies of the twentieth dynasty (about 1250–1000 B.C.).

Considering that our knowledge of man and his ills in early times centered largely about the eastern rim of the Mediterranean, one might naturally expect that the sum total of our knowledge would find its greatest expression in these regions; this, however, unfortunately is not the case. In the case of schistosomiasis, credit for the major unfolding of our knowledge of the subject must go largely to the researchers of Japan and more recently those of China, ably followed and assisted by the white man.

As known today the genus Schistosoma contains three species that are of prime importance as parasites of man, namely *S. hematobium* Bilharz 1852, *S. japonicum* Katsurada 1904, and *S. mansoni* Sambon 1907. To these, four additional species which have occasionally been reported as parasites of man must be mentioned. They are *S. bovis* Sonsino 1876, *S. spindalis* Montgomery 1890, *S. incognitum* Chandler 1926, and *S. intercalatum* Fischer 1934.

Schistosomes are members of the phylum Platyhelminthes, popularly known as "flatworms." This phylum embraces the dorsoventrally flattened, bilaterally symmetrical worms that do not have a true coelomic body cavity.

The phylum embraces three classes:

1. Turbellaria, which contains the nonparasitic, externally ciliate, free-living members.
2. Trematoda (flukes), embracing the flatworms possessing an alimentary canal and no external cilia in the adult stage.
3. Cestoda (tapeworms), whose members are also parasitic and nonciliate but lack the alimentary canal.

The schistosomes are members of the class Trematoda, which embraces several subclasses. One of these, Digenea, contains all the human parasites. The Digenea have one or two suckers, the anterior being always single and median.

[1] Earl Baldwin McKinley, Geography of Disease, *Am. J. Trop. Med.*, **15**, Suppl., 432.

[2] Ruffer, *Brit. Med. J.*, 1910, **1**, 16.

They pass through a complex development, embracing both sexual and asexual generations in different hosts.

Of the various orders of Digenea, schistosomes belong to the Prosostomata, which have the mouth at the anterior end of the body, usually surrounded by a sucker.

Schistosomes belong to the suborder Strigeata, some of whose members are hermaphroditic; others have the sexes distinct. They are parasitic on vertebrates in the adult stage, and the cercarial stage has a bifurcate tail.

To this suborder belongs the superfamily Schistosomatoidea, which embraces the blood flukes and among these the family Schistosomatidae, in which the sexes are distinct. In the adult stage these live in warm-blooded vertebrates.

Tabulating all this, to place the genus in its proper niche in the animal kingdom, we have:

Phylum Platyhelminthes
Class Trematoda
Subclass Digenea
Order Prosostomata
Suborder Strigeata
Superfamily Schistosomatoidea
Family Schistosomatidae
Genus Schistosoma

To fully understand the problems connected with the control of schistosomiasis, it becomes necessary to inquire into the complete life history of the parasite with the hope of finding somewhere a loose rivet in its armament or an unprotected vulnerable heel.

The Life History of Schistosomes

Although the malady produced by Schistosoma was long known, the complete life history of the organism has been unraveled comparatively recently, i.e., that of the members parasitic upon man. Of these, that of *Schistosoma mansoni* appears to have received the most exhaustive scrutiny. I shall therefore give a brief epitome of its ontogeny.

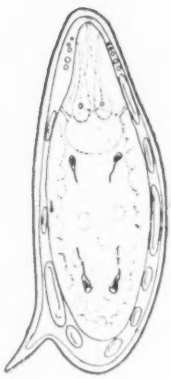
Schistosoma mansoni. The eggs, discharged with the feces of its host, are oval in shape and bear a lateral spine (Fig. 1). In measurement they range from 114 μ–174 μ in length and 45.6 μ–68.4 μ in diameter, averaging 164 μ by 70 μ. When discharged they have already undergone development that has carried them through the early cleavage stages to a well-developed miracidium. The miracidium is very active in the egg when mature. Hatching occurs over a period of 48 hours after the egg reaches water. Faust and Hoffman found that the most suitable water for the hatching and further progress of the miracidium was that secured from the source from which their intermediate molluscan host (Australorbis) was obtained, i.e., water having a pH between 7.3 and 8.1, and that tap water and distilled water registering a pH below 7 were much less satisfactory. Miracidia will remain viable in feces for two to three days at a temperature of 75° to 90° F.

The Miracidium. The miracidium is an oval animal having 21 dermal plates arranged in four series, which from the anterior posteriorly have 6, 8, 4, and 3 plates, respectively (Fig. 3). These plates bear the cilia that propel the organism through the water. The anterior end is cone-shaped, and the spaces between the plates are devoid of cilia.

PLATE I (OPPOSITE)

All these figures of *Schistosoma mansoni* have been copied from Faust's *Human Helminthology* and Faust and Hoffman's "Studies on Schistosomiasis in Puerto Rico."

1. Egg; 2. Dermal plates of miracidium; 3. Miracidium; 4. Cercaria; 5. First generation sporocyst; 6. Second generation sporocyst; 7. Adult worms.



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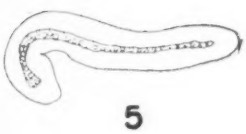

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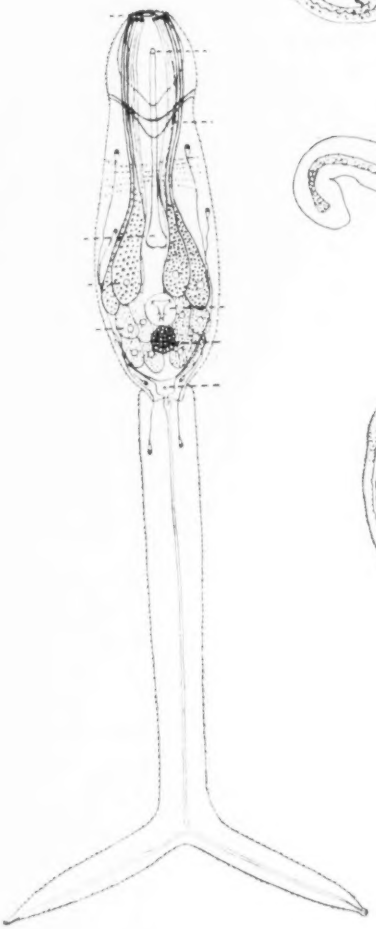

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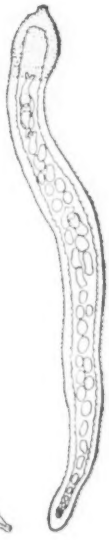

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Beneath the dermal plates of the free-swimming miracidium an epithelial layer and delicate longitudinal and transverse muscle cells are present, the latter being responsible for the changing of the shape of the organism. Within the miracidium there has been recorded (Fig. 3) a large flask-shaped cell whose long neck extends to the center of the head cone. On each side of this is a single retort-shaped anterior secretory gland which discharges into the side at the base of the head cone. These glands give an acidophilic reaction and are believed to secrete the fluid assisting in the penetration of the molluscan intermediate host. Posterior to these glands is the nerve mass, and just below it are the lateral secretory glands, composed of a number of cells with basophilic reaction. These discharge laterally at about the middle of the major part of the anterior gland cells. The excretory system consists of an anterior and posterior pair of flame cells, connected by more or less coiled collecting tubules that discharge on the side of the animal near the anterior end of the posterior fourth. The miracidium thus equipped is ready to seek its molluscan intermediate host. Free miracidia have less than a 24-hour life span in which to accomplish this.

In America mollusks of the genus Australorbis and Tropicorbis have been found to serve in this capacity. In the Old World members of the genus Afroplanorbis perform this function. (Quite a number of mollusks not Planorbid have been cited by some authors as intermediate hosts of *Schistosoma mansoni*, but it is now believed that that citation was due to insufficient discrimination of the Trematode species involved.)

When a miracidium comes near its proper intermediate host it at once heads for it, probably attracted by some secretion of the mollusk. It then burrows into the host, aided by the cilia and the secretion of the anterior glands. The penetration appears to require but a few minutes. The tentacles and head parts of the snail appear to be the preferred points of attack.

Once within the mollusk, migration toward the esophagus and digestive gland takes place, and here the next two stages occur. Shedding the ciliated plates, the miracidium undergoes profound internal changes. The digestive, neural, and glandular structures are resorbed, and in the first sporocyst stage the organism becomes an elongate oval bag functioning as a brood pouch for the development of the daughter sporocysts, the second sporocyst stage. These are developed from the germinal epithelium lining the cyst (Fig. 4). Some 20 to 25 of the second generation are produced by the parent cyst.

The daughter cyst, or second generation, differs materially from its parent (Fig. 5). It has a more elongate worm-like body covered with spinose epithelium. The anterior end is snoutlike and covered with spines. The interior consists of germinal epithelium which develops "germ balls" that gradually, progressively evolve into cercaria. Hoffman has calculated that many tens of thousands of these may result from the infection of a single miracidium. The actual number produced in the case of multiple infections of the snail depends upon the life span of the snail and its powers of endurance. As in the case of the first sporocyst stage, the cercaria break through the body wall of the cyst and pass into the lymph spaces about the digestive tract, passing through the body wall into the water.

The Cercaria. The free-swimming cercaria is a curious creature. It might be likened to a tadpole with a forked tail. The anterior end, or body, of the animal is a depressed oval, separated from the longer, caudal, portion by a decided constriction. The terminal por-

tion of the tail is developed into a bifurcate swimming organ. The entire exterior of the body is beset with minute spines. An oral and a ventral sucker are present. Faust and Hoffman give the following measurements of fixed specimens as follows:

	Range (μ)	Mean (μ)
Length of body	185–230	214
Breadth of body	75–110	92
Length of tail trunk	185–300	225
Breadth of tail trunk	60–75	68
Length of caudal furci	90–130	104

Two pairs of large, granular, flask-shaped acidophilic glands, situated immediately in front of the ventral sucker, and four pairs of small, finely granular, basophilic glands behind the anterior glands are present.

Four pairs of flame cells, three in the body and one in the anterior part of the tail, discharge their products through paired collecting tubules into a common bladder, which empties through a tube at the end of the flukes of the tail. (For a sketch of these structures see Figure 6 which is copied from Faust's *Human Helminthology.*)

Faust and Hoffman found that cercaria bore through the skin of the mammalian host in one hour, sometimes in ten minutes or even less. They are aided in this by the lytic action of the glandular secretion as well as by the mechanical burrowing efforts of the animal. It is this phase that produces the dermal itching symptoms in the mammalian host. In this process of penetration the cercaria shed their tails. They are said to reach peripheral venules of the skin within 22 hours and from there are carried to the right heart and thence to the lung; from the lung they are carried to the left heart and thence by the systemic circulation over the body. Those that successfully reach the portal vessels will grow and mature sexually and finally migrate to the mesenteric plexus, where they mate and produce eggs. (Faust has given a very detailed account of this process in the case of *S. japonicum.*[3])

The adult worm (Fig. 7) may be briefly described as follows: The adult *Schistosoma mansoni*, as well as all the human blood flukes, have the sexes distinct. The male is shorter and broader and stouter than the female and has the sides approximated ventrally to form a tube in which the adult female is encompassed. The male *Schistosoma mansoni* measures 10 mm.–12 mm. in length and is beset with fine tubercles. It has two suckers, the anterior being terminal; the ventral is about one-sixth of the length of the animal behind the oral sucker. The mouth is in the oral sucker. The esophagus, beginning at the oral disc, is surrounded by glands and reaches to the ventral sucker, where it divides into paired ceca which extend to the middle of the body. There they unite to form a winding tube that ends blindly near the posterior end.

The reproductive system of the male consists of eight to nine testes with ducts leading into a *vas deferens* and seminal vesicle which discharges through a genital pore near the ventral sucker. The nephridial system consists of flame cells, whose products are passed by slender tubules into the paired collecting tubules; these convey the excretions into a bladder at the posterior extremity, from which they are discharged through the excretory pore.

The female is filiform, measuring 12 mm.–16 mm. in length. The papillae on the surface are confined to the two ends. The ovary is in the anterior half of the body, and the vitellaria occupy three-fifths of the posterior part. The uterus is short and usually contains one or only a few eggs. The eggs are passed through the oviduct to the shell gland, where they receive the yolk substance, brought

[3] *Am. J. Trop. Med.*, 1946, **26**, 113–14.

here through the slender vitelline ducts. Here also the eggs are fertilized and receive their shells before they are passed into the uterus, from which they are eliminated through the genital pore. They bore their way from the small veins into the intestine of the host by means of the spine and lytic secretions.

In *Schistosoma mansoni* they are normally eliminated with the feces. Those of *S. hematobium* and *S. japonicum*, on the other hand, are voided with the urine.

The anatomic structures of the various developmental phases of *Schistosoma hematobium* and *Schistosoma japonicum* are not unlike that of *Schistosoma mansoni* but sufficiently distinct in almost all phases to require separate naming.

The Molluscan Intermediate Hosts. Since a large part of the schistosome's life is spent in some fresh-water mollusks, it becomes desirable to know the species involved in this capacity. An intimate knowledge of the habitat and habits of the intermediate host may reveal ways and means for eliminating the mollusk, thereby removing links from the chain that constitute the life cycle of the worm and thus exterminating it before it can reach man.

It has now been well established by experiment that only members of the genus Australorbis and Tropicorbis of the family Planorbidae serve in this capacity in America for *Schistosoma mansoni*. The experiments of Wright, Cram, and Jones, of the National Institute of Health, have shown that none of the many other species and genera of this family tested is susceptible to infection.

In Africa members of the genus Afroplanorbis, a group closely related to Australorbis, serve in the same capacity.

The known distribution of schistosomiasis in America is spotty, and that of the intermediate hosts appears equally interrupted. This seeming discontinuity may be owing to our incomplete knowledge of the occurrence of the necessary mollusks as well as that of the parasite. We do know, however, that in endemic centers of schistosomiasis the necessary intermediate host is always present.

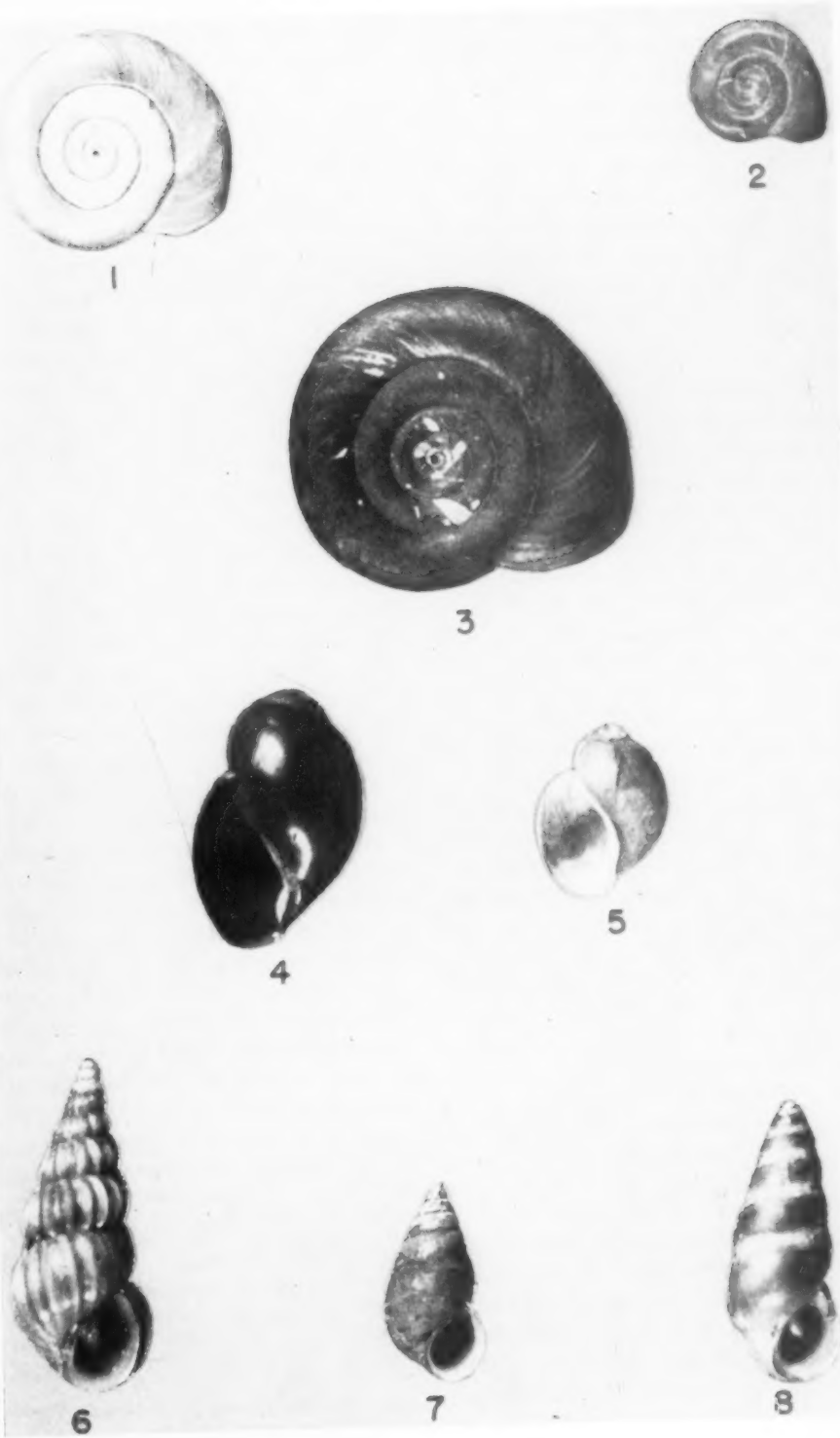
Peripatetic, roving man may carry the infection from place to place, and only if he is careless in the disposition of his waste products in the places where suitable mollusks are present will he become a focal point for new infections. Education in sanitation, particularly the elimination of human wastes, among unenlightened primitive people, therefore, constitutes the best approach to the elimination of this and other maladies. Unfortunately, we know only a little about the other mammals also subject to infection. The elimination or curtailment of the disease where it is not restricted to man, as, for example, in *Schistosoma japonicum*, presents a much more difficult problem, probably best approached through the elimination of the intermediate molluscan host. To accomplish this it becomes necessary to know the ecologic conditions under which the mollusks in question can exist.

The adjustment of fresh-water mollusks to hydrogen ion concentration was

PLATE II (OPPOSITE)

These figures depict representatives of the various genera that serve as intermediate hosts for human schistosomes. Figures 1–5 have been enlarged to double natural size; figures 6–8 five times.

1. *Afroplanorbis boissyi* (Michaud); 2. *Tropicorbis orbiculus* (Morelet); 3. *Australorbis glabratus* (Say) [=*A. guadaloupensis* (Sby)]; 4. *Physopsis africana* (Krauss); 5. *Bulinus truncatus* (Michaud); 6. *Oncomelania hupensis* (Gredler); 7. *Schistosomophora quadrasi* (Möllendorff); 8. *Katayama nosophora* (Robson).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first brought to my attention many years ago at Washington, D. C., where I noted that the Potomac River harbored certain species which were not found in its side streams. The explanation for this was the fact that the Potomac waters, thanks to the contribution of the Shenandoah's limy waters, were slightly alkaline in reaction, whereas the side streams, fed by springs charged with organic acids (tannic, humic, succinic, etc.) furnished by decaying vegetation, yielded an acid reaction. Hence, a decided difference in environment is responsible for the distribution of their molluscan fauna.

This same state of affairs I found in my explorations for mollusks in the West Indies. This can be best visualized by describing an experience I had on the island of Grenada. This high island of the Lesser Antilles is covered with forests and plantations of cacao, bananas, oranges, nutmeg, and sugar cane. The soil being noncalcarious, excepting a coastal strip which represents an elevated coral reef on the Atlantic side, nowhere in the streams coming from the mountains did I find Australorbis or Tropicorbis. In the coastal plain of the northeast corner of the island is a place called Mineral Springs. Here a number of small springs well up through the limestone. These form pools of varying size and join to form a small stream. This water coming up through the limestone reef is alkaline. Here I found Australorbis and a host of other mollusks flourishing amid masses of blue-green algae in such abundance that I filled my half-bushel collecting basket in no time. This faunula extended for a space of a few squares; then the streamlet joined a mountain brook, which terminated its molluscan distribution like a screen. The mountain stream, like all the high mountain streams that I examined in this and other islands, was acid in reaction, therefore unsuited for the calciphilic Australorbis and Tropicorbis.

Later I found the same but much more extensive fauna in the streams of the limestone mass on the bay side of the island of Trinidad, whence the ancestors of the Mineral Spring mollusks had evidently been carried as eggs or young to Grenada, some 130 miles distant, on the feet of migrating water birds.

Australorbis guadaloupensis (Say) took its name from the island of Guadeloupe. The name Guadeloupe has been used to embrace both Guadeloupe proper (Basse-Terre) and Grande-Terre. I found no Australorbis on Guadeloupe proper, but on Grande-Terre, which is an elevated limestone mass, they were present in great abundance. Here the natives dam off valleys to hold the water during the rainy season. These slightly alkaline pools furnish the water supply of the region and are literally paved with the living and dead shells of Australorbis. Here the natives come for water with their empty five-gallon kerosene cans. The shores of some of the most populous places I found strewn with human feces. If the individuals contributing them were carriers of *Schistosoma mansoni* and rain washed the fecal material into the ditch, there would here be an ideal condition for the establishment of an endemic center. Natives are proverbially careless in the deposition of their wastes.

Another place where conditions were found to be ideal for schistosomiasis was on the island of St. Christopher. I shall quote from my journal (1929, p. 40):

> Instead of stopping at Monkey Hill, which I found to be barren and uninviting, we went to the next mountain and collected on the Fountain Estate owned by Mrs. Barkley. Not far from the house I found a narrow gorge choked with tropical vegetation: palms and treeferns, many araceous things, rose apples, etc., etc.; and a babbling brook tumbling over many cataracts and expanding into many small pools literally teeming with *Australorbis guadaloupensis* of which I gathered about five hundred. Many years ago the African gray monkey, *Cercopithicus*, was introduced here and has found a very

suitable home with no enemies except man. I saw several of them cautiously eyeing me from afar and swinging away into dense cover after having given me the once-over.

This combination of monkey and Australorbis is not only interesting but important, because the monkeys are known to harbor *Schistosoma mansoni*. I was told by the resident doctor that the intermediate host was not known on the island. I should not like to bathe or drink from this stream which supplies the Fountain Estate and part of Basse-Terre with water. The monkeys probably become infected by drinking the water. The boys with me said that the monkeys ate the mollusks, which may be true.

Dr. S. B. Jones, resident physician of St. Christopher, has estimated that 25 percent of the inhabitants are infected. (The 1911 census cited 26,283 inhabitants.)[4]

In the West Indies Australorbis is known in Jamaica, Haiti, Dominican Republic, Puerto Rico, Culebra, St. Christopher, Nevis, Montserat, Antigua, Grande-Terre (Guadeloupe) Marie-Galante, Martinique, and Trinidad.

Having only a two-masted sailing vessel at my command, I did not risk cruising along the dangerous ironbound Atlantic side of the Lesser Antilles. I was therefore able to explore only such portions as could be reached by overland trips. It is quite likely that future explorations may reveal Australorbis in parts of the Atlantic coastal strips such as that described for Grenada. On the mainland Australorbis ranges from Venezuela to Argentina.

The nearly related genus, Tropicorbis, some members of which have been found by Wright, Cram, and Jones to be subject to *Schistosoma mansoni* infection, ranges even farther than Australorbis. The U. S. National Museum contains specimens from the mainland from Louisiana, Texas, New Mexico, Mexico, Yucatan, Venezuela, Nicaragua, British Guiana, Brazil, Argentina, Uruguay, and Chile; in the islands we have it from various places in the Bahamas, Cuba, Isle of Pines, Jamaica, Haiti, Puerto Rico, Antigua, Barbados, and Trinidad. There is a possibility that all the species involved may serve as intermediate hosts for *Schistosoma mansoni*.

In Africa and adjacent territory members of the genus Afroplanorbis serve as intermediate hosts of *Schistosoma mansoni*. The species of this genus range through northern and central Africa. The scant information at hand indicates that this genus, like Australorbis, lives in an alkaline habitat.

In their adjustments to intermediate hosts we find great differences. *Schistosoma hematobium* and *Schistosoma japonicum* require mollusks living in a slightly acid habitat. *Schistosoma hematobium* is partial to mollusks belonging to the family Bulinidae, the subfamily Bulininae of which the species of the genera Bulinus and Physopsis have definitely been implicated.

In Portugal some Planorbis have been listed as furnishing an intermediate host. This conclusion should be re-examined. It is more likely that the worm implicated was *Schistosoma mansoni*.

Schistosoma hematobium has been reported from Egypt, Asia Minor, South Africa, East Africa, Morocco, and Portugal.

Schistosoma japonicum ranges from Japan south through the Philippines to Celebes and on the mainland from China to Siam.

The known mollusks involved as intermediate hosts of this species belong to the family Hydrobeidae and the subfamily Hydrobeinae and are embraced by the genera Katayama, which ranges through Japan and China; Oncomelania in China; and Schistosomophora in the

[4] *J. Trop. Med. and Hyg.*, 1922, 25, 25–27; 1923, 26, 243–254; 1931, 35, 129–36.

Philippines and China. No members of these genera are known from Celebes and Siam. It is possible that the cases reported from there were in human immigrants from China and that the disease has not become established there for want of a proper intermediate host.

While not all species of the genera listed have been definitely implicated, it is most likely that they will serve as intermediate hosts when and where opportunity occurs.

I have refrained from discussing the medical phase of this subject or even citing titles of papers thereof for that would require more printed pages than have been allotted to me. That phase of schistosomiasis must be looked for in medical textbooks and in medical journal literature.

My suggestion for elimination of the molluscan intermediate host would be to crush limestone and scatter this in places found to contain the intermediate hosts of *Schistosoma hematobium* and *Schistosoma japonicum*, which field tests have shown to be slightly acid in reaction. Yoshida, at my suggestion, put this in effect in Japan with good results. The control of the intermediate host of *Schistosoma mansoni* presents a more difficult problem since these mollusks are addicted to alkaline waters. Copper salts of various kinds have been employed in concentrations not detrimental to human beings or household animals, with some success. It is possible that some of the newer toxins such as DDT and the many others now undergoing tests may prove useful and efficacious.

SONNET ON KNOWLEDGE

Petal by petal shall the flower unfold
To lay its fragrance on eternal day—
The blue of lupine, the rose in her array,
Nasturtium's August fires, the marigold . . .
We see a chart of miracles unrolled—
That daffodils should rise from frozen clay,
Black dogwood whiten into ocean spray,
And ferns uncurl from out a wet leaf-mold!

So is the Mind-of-God an opening flower . . .
O blazing lily of a night of stars!
O angel wings beyond the mortal range!
Though knowledge like a gathering storm may lower,
A bud unfolds—of atom, moon, or Mars—
A luminous bloom of heaven, bright and strange!

Barbara Whitney

Winner of the Virginia Lyne Tunstall Prize for a Petrarchan Sonnet.
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THE RISING QUALITY OF NEW WORLD ARCHEOLOGY*

By NEIL M. JUDD

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THOMAS JEFFERSON was merely satisfying his curiosity when he opened a low earth mound near Charlottesville, Va., in 1780. His surprise probably equalled that of his Negro slaves when the contents proved to be a thousand Indian skeletons.

Caleb Atwater, in 1819, was the first to attempt a general account of the diversified Indian mounds in Ohio. In the very first volume of that famous series "The Smithsonian Contributions to Knowledge" Squier and Davis in 1848 undertook to describe and explain the ancient monuments of the whole Mississippi Valley.

Because certain Mississippi Valley mounds outwardly resembled pyramidal structures they had seen far to the south, Squier and Davis believed all were built by a tribe closely related to the highland peoples of Mexico, Central America, and Peru.

William Bartram, the American naturalist, noted many earth mounds, both large and small, during his travels throughout the southeastern states. Because he could not believe that local Indians had either the ability or the energy to construct them, Bartram attributed those mounds to an extinct race, the "Mound Builders."

Since the American Indians, like the Jews, were divided into tribal groups they became the "Lost Tribes of Israel" to many a credulous person. Others were equally positive of a Danish or Welsh origin. The myth of a submerged Atlantis, first recorded by Plato nearly four hundred years before Christ, still has its unyielding adherents, although recent years have brought forth a Pacific rival, the "Lost Continent of Mu."

These fictions and diverse surmises, however naive they may seem to most of us, represent a definite period in New World archeology, the period in which speculation substituted for fact.

One of our cherished American privileges is that of free speech. And we have heard more gratuitous expressions on archeology than on any other subject except politics. Personal opinions, however, are not all of equal worth. The man leaning across the fence as a Diesel-drawn train rockets past may have positive ideas on its operation, but the one actually at the controls can speak with greater authority. He has the background in training and experience that provides substance for an opinion.

But let no one frown on the man with imagination! Imagination is the spark-plug of archeology. It starts the engine and keeps it going. Together, imagination and intuition have retrieved dead civilizations from their rubbish heaps and crumbled masonry; together they have recreated the lives of peoples nameless in history. It was a combination of intuition and imagination based on long experience that identified the site of ancient Ur and peeled its successive foundations one from the other.

Consciously or unconsciously, each generation learns from its predecessors, and we of the present are not exceptions. We have learned by being critical of our teachers and by seeking to improve upon

* Address of the retiring president, 44th Annual Meeting, American Anthropological Association, Philadelphia, December 28, 1945.

their methods. Some were too imaginative; some misinterpreted the simple facts before them, at least from our point of view. But the majority erred only in treating their subject matter a little more broadly than is the practice today. Theirs was descriptive rather than analytical research.

I have heard one of the stalwarts of the last generation criticized for failure to recognize the ceramic complex on which southeastern archeologists now lean so heavily. The speaker seemed quite unmindful of the fact that the object of his censure had died five years before that complexity was first created. Until our younger students pointed out its internal and external differences, southeastern pottery offered no problem.

The current tendency in every walk of life is toward specialization. We hew to a finer line. The old-time naturalist is now a rare bird. Gone is the day of the general practitioner! Even the archeologist limits his efforts, say, to the Eastern Woodlands, the Maya Area, or the Peruvian Coast.

In focusing upon an ever-diminishing field of inquiry, archeologists of the Western Hemisphere have gradually altered their concept of archeology and their approach to it. Closer observation and a careful weighing of elements previously thought unimportant are among the desiderata today.

One of the parent organizations of the American Anthropological Association is the Anthropological Society of Washington, founded in 1879. The title of the address at its first formal meeting was "Relic-Hunting." At a recent meeting of the Society the subject of discussion was a proposed organization exclusively for professional anthropologists. You see what advances we have made in sixty-odd years! Henceforth, if not illegal, it will be positively immoral even to hunt arrowheads without a doctorate.

Within sixty years the prime purpose in American archeology has completely changed. Recovery of history, prehistory, is the object now. No longer does one condone pot-hunting under the guise of science. In seeking to reconstruct the culture of an extinct people, it seems most logical to proceed from the known to the unknown; to begin with the earliest written record and work backward. I will not pretend that institutional relic-hunting has wholly disappeared or that every field worker concerns himself with painstaking examination of his findings but, in both respects, there has been marked improvement even within the brief span of my own observation.

In the old days archeological problems were solved by fiat and by table pounding. You can't do that now! Now you must have facts. You have got to have what we in the profession call "data." You should rely upon stratigraphy and tree-ring dates whenever possible. You must concoct a distinctive designation for every local variation in pottery. You must determine the dominant types and you will get nowhere at all unless you can figure trait percentages.

One of the first positive efforts toward improved techniques was made in the southwestern United States some thirty years ago. A few young investigators were then giving thought to sequential developments in Anasazi culture. The stratified deposits of old village dumps contained incontestable proof. From that experimental beginning the stratigraphic method gradually evolved and, with improvements, has since become a thoroughly dependable procedure. Its influence has been felt wherever American archeologists are engaged with field work.

Culture variations and sectional differences are now generally recognized. Local preferences in art, architecture, and the tools of industry have been disclosed. Food habits have been indicated

here and there and pre-Columbian commerce demonstrated by the finding of objects far from their place of origin. Dendrochronology, wherever applicable, has provided a measure for prehistoric time more accurate than that available to archeologists elsewhere in the world.

Under the more precise methods now current, archeology has everywhere made noteworthy advances. The antiquity problem has been under scrutiny again; new evidence conclusively proves the contemporaneity of early American Indians and extinct mammals commonly accredited to the late Pleistocene. Comparable evidence forty years ago was shouted down because geologists, paleontologists, and archeologists had not yet learned to cooperate on problems of mutual interest. Too, the rugged individualists of the last generation did not trust one another's judgment in matters of antiquity.

Investigators in Mexico and Central America have brought increased order and understanding to the pre-Spanish history of their respective countries. Eventually this whole fascinating tangle will be unraveled and each thread traced to its point of origin. Then, perhaps, we shall know what preceded the "Archaic"; we may even find trace of those trail blazers first, theoretically, to funnel through Panama.

Stratigraphy has again played an important part in clarifying the archeological picture in South America. Here representatives of the Institute of Andean Research have joined forces with local authorities on ten major projects between Venezuela and Chile. These were planned primarily as fact-finding expeditions; excavations were largely restricted to testing trash piles at carefully selected sites. The purpose was to isolate, insofar as possible, the basic cultures of the area and to trace their interrelationships. The early harvest of this cooperative undertaking includes stronger bonds between archeologists in the participating republics and no fewer than twenty-two separate papers reporting their observations. Excavations at Cuzco provide our first factual picture of Inca civilization at its height.

Among the many that might have been cited, these few examples will suffice to illustrate my point, namely, that New World archeology has risen in quality directly in proportion to the dependence of its reporters upon precise data. There is a great deal more to archeology than digging relics. Trait lists, diagnostic types, analyses of diverse items, the identifiable remains of birds, beasts, and plant products—all these, and more, provide the detailed information necessary to the successful reconstruction of a prehistoric culture.

These reconstructions, of course, are not complete and never can be. They are based for the most part on imperishables such as stone, bone, and pottery. Knowledge of things that decay—fabrics, basketry, tanned hides—must be inferred or deduced from charred remnants, chance imprints, and the existing flora and fauna of the district. One must guess at the social system represented and its esthetic values.

That the quality of New World archeology has improved through attention to particulars previously neglected is less a reflection upon our immediate predecessors than upon the period in which they lived and worked. A generation ago museums gauged the success of field parties by the bulk of material recovered. Today major effort is directed toward the intangible. Experience proves that those expeditions which have contributed most to knowledge have been carefully planned in advance, have continued over a period of years, and have enlisted the aid of workers in other disciplines. Rarely can one dash out for a few weeks and return with anything worth while by current standards. Museums still

want specimens, to be sure, the better to illustrate advances in knowledge and thus fulfill their mission in public education. But the collection, as such, is no longer the principal objective of leading research institutions.

Progress always seems snail-slow when measured too soon. True perspective is best gauged from a distance. And so it is with archeology in the New World—those of us who have been in it a long while can see the rise in the quality of field work that began when emphasis first turned from specimens to their associated data.

AND where do we go from here? For one thing, I anticipate a slower pace for a time. I believe we have advanced too far too fast. I believe the balance will soon tip the other way again, that we will become a little less "scientific." The diverse elements that go to make up a given culture complex will be weighed without bias; research reports will be written with less parading of ponderous verbiage than echoes from some quarters today. We will probably display more caution in analysis and classification. For example, a recent study sets up, among others less conspicuous, five new pottery types on the basis of, respectively: 1 complete vessel and 7 sherds; 1 vessel and no sherds; 2 sherds; 1 sherd; 2 complete vessels and 12 sherds. As type determinatives, such evidence looks pretty flimsy.

Much has been accomplished in the past quarter century and much remains to be done. There are still many questions to be answered, many puzzles to be solved. And there is salvage work to be done also. The vast reclamation and flood-control program now in prospect for every major river valley in the United States will bring ruin to thousands of Indian village sites, ceremonial units, and burial places. Their destruction will be complete and final. With them will go for all time the wealth of information that could have been saved had there been influential spokesmen in high places. Engineers and politicians building for tomorrow will not be delayed by yesterday's leavings!

LANGLEY

Pondering the buzzard's flight
A genius drew
The inspiration to translate
Man to the blue.

Now dreadful fruit of that ascent
Holds earth in dread.
He will not grudge the bitter laurels
From his silent head.

M. H. PALMER

ECOLOGICAL COUNTERPARTS IN BIRDS

By HERBERT FRIEDMANN

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IN THE present usage of technical language to express and to conceal the complexities of the animate world, its contents and its activities, its processes, past and present, and its interlocking patterns and coordinations, it is no longer fashionable to personify "Nature" and to attribute to it anything remotely resembling plan or feeling. However, there used to be current an old expression which, in spite of changing points of view, still conveys a truth of general validity, although its purely rhetorical construction may be considered in need of renovation: "Nature abhors a vacuum." The only reason this statement has a continuing validity is the fact that it is so difficult to find in nature a vacant niche, an untried method, or an unrelated, isolated, hence, "vacuum-surrounded," process. The thoughtful observer quickly comes to realize this state of affairs and, in the verbiage of an earlier generation, to conclude that Nature appears to have "tried everything" at least once.

When we come to more specific cases, when we limit our search to more strictly comparable materials and situations, we are often forced to the conclusion that frequently there is a repetitious sameness in the end results; that similar niches are often filled by convergently similar, but originally quite divergent, forms. The more complete our knowledge of any given group of organisms, the more such cases come to mind. In the present essay we wish to point out, merely as random samples, a number (but only a small part) of what might be termed striking ecological and morphological counterparts in a single vertebrate group—the birds.

It seems desirable to further restrict the survey to cases personally observed and studied in the field, in North and South America and in Africa. The instances cited below are of unequal value since the actual information available, as contrasted with the mere general impression received in the field, varies greatly and also since the cases are of different degrees of convergent similarity. Some of the cases are well known; others appear not to have been recorded previously.

PERHAPS the "classic" case of this sort and, indeed, one of the most striking is the amazing similarity in appearance and in general habits of the American troupial genus *Sturnella* (the meadowlarks) and the African pipit genus *Macronyx*. Both are "unusual" members of their respective families as far as their coloration goes—the upperparts streaked blackish, brownish, and pale buff; the chin, throat, breast, and upper abdomen, bright yellow with a broad black pectoral band. The similarity is carried even to the white outer tail feathers in the two genera. Both *Sturnella* and *Macronyx* inhabit grassy open spaces; both make somewhat arched-over, or semidomed, nests of dry grasses on the ground; both have the habit of turning away (that is, of hiding their brightly colored underparts) from an approaching observer; both spread the tail, showing the white lateral feathers as they fly, and both have a somewhat melancholy whistling note. To make the case even more complete, one species of *Macronyx* (*M. ameliae*) has the underparts pinkish red instead of yellow, paralleling the red-breasted near relative

of *Sturnella,* the genus *Pezites* of South America, again a bird of similar habits.

The large family of weaver-birds (the *Ploceidae*) fills many ecological niches in Africa that are occupied in the Americas by some of the troupials (*Icteridae*), by some tanagers (*Thraupidae*), and by some of the finches (*Fringillidae*). There are in this assemblage numerous instances of close convergence in which the plumage patterns are remarkably similar and in which there are related similarities in habits as well. Thus, the males of the long-tailed weavers of the genus *Diatropura* have a nuptial plumage exactly paralleling that of the American red-winged blackbird (*Agelaius phoeniceus*) except for the greatly elongated tail feathers of the former. Both birds are uniformly and solidly black, with buff-edged red patches on their outer, lesser, upper wing coverts forming "shoulder patches" or "epaulets." Both indulge in essentially similar courtship displays—arching the wings, raising these red "epaulets" and bowing forward, although *Diatropura* also goes through a bouncing aerial dance over the female; both live in similar reedy, rather lacustrine, habitats. Both have marked sexual dimorphism, the females in both being heavily streaked in pattern. In *Diatropura* the black-and-red plumage is seasonal, whereas in *Agelaius* it is worn throughout the year. Weavers of the genus *Urobrachya,* closely related to *Diatropura,* but without the long feathers, also exhibit marked resemblances toward *Agelaius.*

Numerous African species of weavers of the genus *Ploceus* present general resemblances to many American troupials of the genus *Icterus,* the plumage pattern of various combinations of yellow or yellow-orange with black and white being repeated in different species of the two groups. Both genera have similar nesting habits of weaving their pendant nests from the terminal branches of sizable trees, although the weavers are more inclined to nest in loose colonies (that is, many nests in one tree) than are the troupials. Even though the two groups have somewhat dissimilar feeding habits, seeds being the main diet of the weavers and insects the chief source of nourishment of the troupials, the most casual observer would soon come to sense a decided similarity between them in their general appearance and in their actions.

A group of forest-dwelling weaverbirds of the genus *Malimbus,* unlike the much larger genus *Ploceus,* are red and black in color and are paralleled in the American tropics by a similarly sylvan genus of largely red-and-black tanagers, *Ramphocelus.* In their general appearance and actions the two have much in common, although their nests are quite dissimilar.

One of the small, somewhat "nontypical," genera of weavers, *Hypochera,* comprises a few forms, the males of which are solid, deep blue-black, with pale bills; the females, streaked brown and buffy. They are surprisingly similar in both sexes and in their young (juvenal plumage) to a South American finch, *Volatinia jacarini.* Both birds are largely terrestrial, procuring their food —grass seeds and seeds of low plants— on the ground, and both are given to using somewhat elevated perches when not feeding. Some twenty years ago I wrote in my field book the following, then fresh, impression:

> . . . . *Hypochera* seems the ecological as well as the visual counterpart in Africa of *Volatinia* of the American tropics, and it is rather surprising to find that both have a bouncing type of courtship display, similar call notes, and similar songs. In both the display is fairly primitive, there being no specialized feathers or other structures involved. The display is a bouncing aerial dance, the bird literally jumping or bouncing off its perch into the air several times. The whole display lasts about three seconds and is accompanied by a guttural, beady song, which is very jerky as though the rhythmic bounces of the bird interfered with its delivery.

Naturalists familiar with North American or European birds are accustomed to think of shrikes (*Laniidae*) as gray, white, and black birds of strictly carnivorous habits, feeding largely on small birds or mammals or large insects. In the African tropics there are additional species of "typical" shrikes of essentially similar form and habit, but there are a good number of brilliantly colored species known as "bush shrikes," with red, yellow, green, and blue markings in varying combinations. These bush shrikes leave on the observer the same impression that do tanagers in the Americas, and while there are no definite species of the two groups that closely approximate each other in pattern, the impression does not become diminished because of this lack of specific instances of convergence. The two groups make quite similar nests; their general actions are quite reminiscent of each other, although their diets are not wholly similar, the tanagers being more addicted to fruits and less to insects than the bush shrikes. But, as shrikes go, the bush shrikes are less strictly carnivorous than their northern relatives; they do eat some fruits and vegetable matter and, where carnivorous, they are restricted to insects, apparently never attacking smaller birds or mice. On the other hand, the tanagers, although frugivorous, also consume quantities of insects. Such species of bush shrikes as comprise the genus *Chlorophoneus*, for example, are quite clearly ecological and visual counterparts of such tanagers as *Thraupis* and *Piranga*.

The role of leaf-gleaning insect feeders played in the New World by the vireos (*Vireonidae*) is filled in the tropics of the Old World by the superficially very similar white-eyes (*Zosteropidae*). The birds of the two families are alike in general size, form, and dull-green coloration (with a few exceptions) and in their actions as well. In field notes made in South Africa in 1924 I noted of one of the white-eyes, *Zosterops virens*, that

> . . . . at Woodbush, Transvaal, this species was breeding commonly, and I found nine nests. The nests are similar in appearance to those of the red-eyed vireo (*Vireosylva olivacea*) of North America, but have the horizontal supporting twigs, from which the nests are hung in a semipensile fashion, slightly below the rims of the nests. . . .

In some species, then, even the nests are similar, and the parallelism between the two groups is marked indeed.

In tropical America there is a large and quite diversified family of what are essentially tree-climbing birds, called the woodhewers (*Dendrocolaptidae*). These birds, with rather stiff woodpecker-like tails that serve as props as they climb about on the tree trunks, are frequently streaked in coloration—browns of various degrees of depth, with some blackish, buffy, and pale tawny. They are bark gleaners in their feeding habits, probing with their highly specialized and diversified, variably shaped bills into crevices of the bark or even pecking at the wood for their insect food. A striking parallel to them in North America and Europe is afforded by a genus of a quite unrelated family, the creepers (*Certhiidae*). Our common brown creeper, *Certhia familiaris*, is so similar, in an admittedly superficial way, to some of the smaller woodhewers that if a specimen of it were placed in a tray of the latter group it would take the eye of an experienced ornithologist to pick it out.

The babbling thrushes, or babblers (*Timaliidae*), of the Old World contain numerous forms (such as the genera *Crateropus* and *Turdoides*) which take the place ecologically of the thrashers and mockingbirds (*Mimidae*) of the New World. In fact, so close is the general agreement that if one of our thrashers were to be taken, let us say, as an escaped cage bird in Asia or Africa, it

would undoubtedly be assumed to be a babbler. (At the risk of spoiling this case from the standpoint of the present paper, it may be asked if the *Mimidae* really are a family separable from the *Timaliidae*.)

In the Americas the role of nectar- and nectar-insect feeders is filled by the large and highly specialized family of hummingbirds (*Trochilidae*). In the tropics of the Old World the same niche, or series of niches, is filled by the quite unrelated, but often similarly brilliantly colored and small-sized sunbirds (*Nectariniidae*). Both groups comprise many species and are quite divergent within themselves in minor details. In the American tropics the honey-creepers (*Coerebidae*) also help to fill this niche. The general resemblance between many of the sunbirds and the hummingbirds is close enough to baffle the nonornithological taxonomist, which is merely another way of saying that it is very considerable. The specialist can easily distinguish them, and his particularized knowledge may tend to make him less appreciative of the similarity between the two groups, as he no longer sees them with ordinary eyes.

THE number of like instances may be extended to the point where it grows wearisome, and we may merely mention, again only as samples, two cases of much less perfect parallelism which are, nevertheless, in the same general category as those already briefly described.

In the forests of the American tropics are numerous forms of brightly colored jays (*Corvidae*), whereas in the similar sections of Africa we find none of these birds, although other members of the same family—the "true" crows and ravens—occur in the open savanna districts. In the African forests the jays are replaced ecologically by a wholly unrelated group of birds, the turacos (*Musophagidae*), a family related to the cuckoos. The forest-dwelling species of turacos are of about the same size (with one exception) as the jays, are of bright, though very different, coloration, make fairly similar nests, and have similar feeding habits. In the open savanna country of Africa are to be found some plain-colored species of turacos, which, in a very loose way, may be said to take the place of the rather drab jays of the genus *Psilorhinus* of similar habitats in tropical America.

The fowl-like birds (*Phasianidae*) of the Old World are largely replaced ecologically in tropical America by the tinamous (*Tinamidae*), a more "primitive" group which has come to occupy the place taken in Africa by the francolins and spur-fowl (genera *Francolinus* and *Pternistes*). The parallelism here is far from perfect, and while the birds of the two groups do fill the same ecological niches there is little similarity between their plumage patterns.

The number of possible permutations and combinations of the different colors and patterns (spots, bars, stripes, etc.) found in birds is far greater than the number of kinds of birds. It is therefore interesting, and probably significant, that there should be as many instances of convergence among unrelated groups as there are. It is all the more intriguing when we find that these similarities in appearance are so often correlated with equally marked similarities in habit.

SCIENCE ON THE MARCH

THE CURRENT SUNSPOT TREND

THE year 1946 has seen the largest number of sunspots that have appeared in the present cycle, which started from a minimum in the early part of 1944. In the first week of February of this year the largest sunspot ever to be observed in sunspot history was in appearance and was accompanied by magnetic disturbances, blackouts in radio communication, and brilliant displays of the northern lights. The important relation between sunspots and radio communication conditions has given rise to a new interest in the prediction of the sunspot curve. So intimately related are the optimum usable frequencies for world-wide radio transmission to the number of spots appearing on the sun that if we know the behavior pattern of one of these variables we can, with reasonable assurance, deduce the other.

Long-distance radio communication depends upon the ability of the ionized regions of the upper atmosphere to turn back the transmitted sky wave earthwards, thus making reception over long paths possible. The reflection of radio waves is an electromagnetic phenomenon which depends upon the ionic concentration, or the electron density, at the reflecting layers. This ionization seems beyond much doubt to be due to radiation at the extreme ultraviolet end of the solar spectrum, an emission which increases rapidly with the increasing number of sunspots. By sending radio pulses directly upward and catching the return wave on the oscilloscope, one can determine the height of this reflective ceiling by measuring the number of microseconds that have elapsed between the record of the outgoing and the returning pulse. Furthermore, by constantly raising the frequency during this operation, a frequency may be found at which the wave penetrates the reflecting layer and fails to return. This is commonly known as the *critical frequency* and is a measure of the electron density existing at the time the observation is made. The accompanying graph (Fig. 1) shows how remarkably the electron density at the E layer, often termed the Kennelly-Heaviside layer, varies with the number of sunspots. The upper curve is the result of plotting the running means, or moving averages, of the sunspot numbers, taking twelve months at a time from 1934 to 1946. The lower curve represents the number of electrons per cubic centimeter at E-layer levels 70 miles above the earth's surface, as calculated from observed critical frequencies over Washington. It is from this layer that waves of medium frequency such as are used in commercial broadcasting are reflected back to earth. An examination of this curve will show that whereas there were the equivalent of 160,000 electrons per cubic centimeter in the atmosphere at the E layer during sunspot maximum in 1937, there were but 111,000 electrons per cubic centimeter at sunspot minimum in 1944. The change in ionization between sunspot minimum and sunspot maximum is approximately 45 percent. To predict ionization conditions during the next year or two, one must anticipate the future of the sunspot curve.

It is a bit surprising that although sunspots have been observed for over 300 years we do not yet know what makes them. It is common knowledge that sunspots are due to atmospheric disturbances in the surface layers of the sun. Whether or not the cause of these disturbances is deep-seated and is to be found within the sun itself or whether there are some ex-

terior factors of a more or less periodic nature responsible for the occurrences of sunspots is still a debatable question. If we knew the ultimate cause of these solar disturbances, it would probably help very much in solving the mystery of the solar cycle and predicting the future behavior of the sun. Some astronomers beg the question and assume that its future is unpredictable.

Various methods have been employed by many workers in an endeavor to improve sunspot predictions. In view of our lack of knowledge, only some empirical method based on the general pattern of recurrences can be used in making estimates of the future of the sunspot curve. Mathematicians have spent many hours in applying harmonic analysis, utilizing all the data available from the beginning of sunspot observations in 1750. However well such an analysis may reproduce past performance, almost invariably it fails in predicting the future. Any systematic study of the records of sunspots will reveal that while the time between maxima and minima has averaged about 11 years, the interval has actually varied all the way from 9 to 17 years. The chance that a given sunspot maximum may be predicted by adding 11 years to the previous maximum is only about one in four. However, there does seem to be some general pattern that the sunspot curve will follow when it is once started on a given

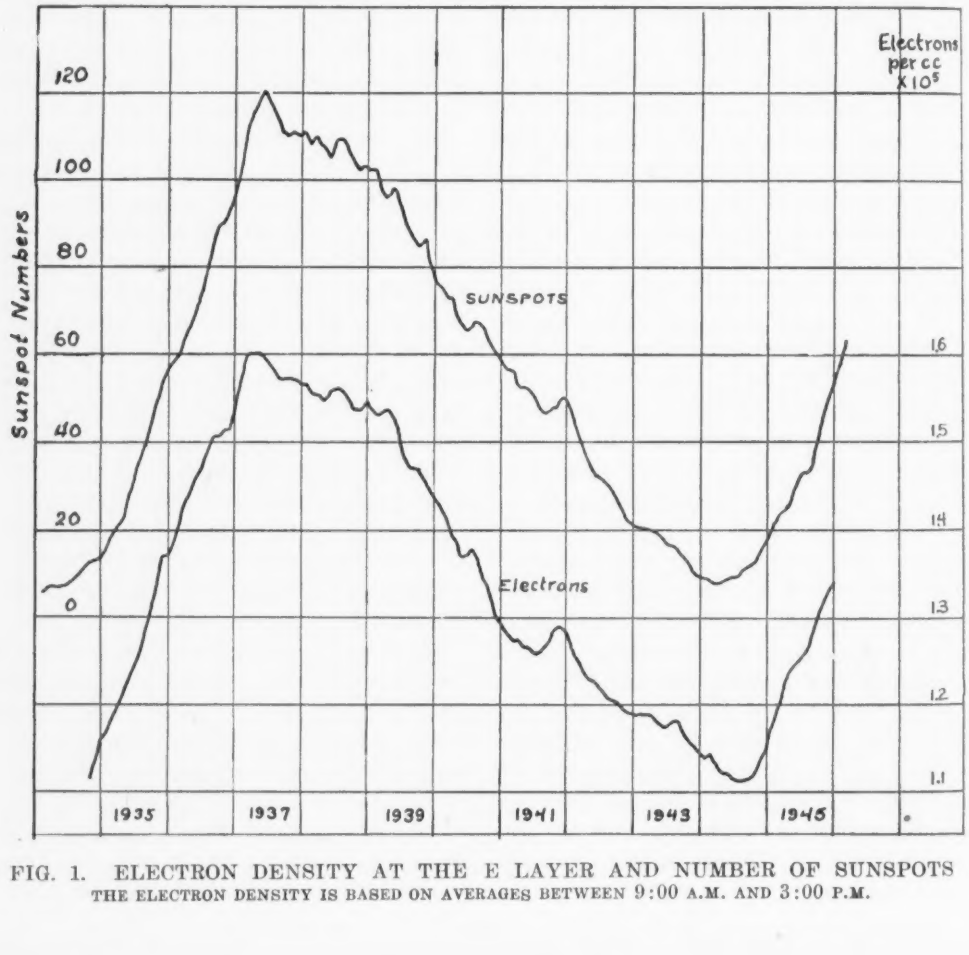

FIG. 1. ELECTRON DENSITY AT THE E LAYER AND NUMBER OF SUNSPOTS
THE ELECTRON DENSITY IS BASED ON AVERAGES BETWEEN 9:00 A.M. AND 3:00 P.M.

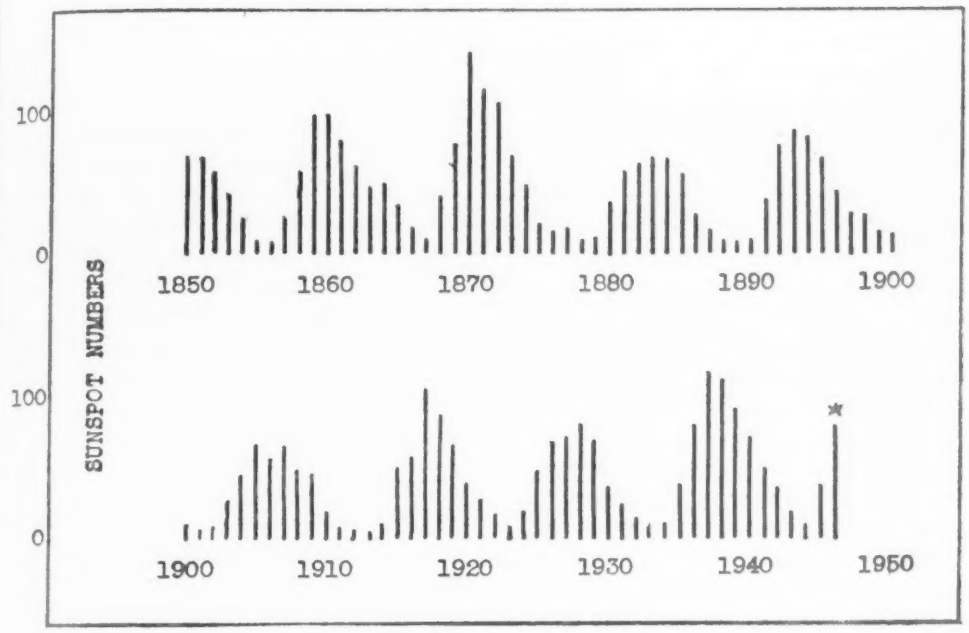

FIG. 2. SUNSPOT CYCLES, 1850–1946

THE NUMBER OF SUNSPOTS FOR EACH YEAR IS SHOWN; THAT FOR 1946* IS A 7-MONTH AVERAGE.

cycle. Dr. John Q. Stewart, of Princeton University, and his associates have recently devised a method for predicting the time of sunspot maximum, treating each rise and fall as an individual event without making any assumption as to long-term periodicities. Studying a number of these individual outbursts, Dr. Stewart has devised a formula for predicting the remaining course of a given sunspot cycle with relatively good success. He has communicated to me his prediction of the next maximum as 1948.0. Dr. C. N. Anderson, of the Bell Telephone Laboratories, in a paper recently published, ventures 1951 as the year of the next maximum. More recently, Waldmeier, in the *Journal of Terrestrial Magnetism*, has predicted a maximum as early as 1947.6. The methods used at the Cosmic Terrestrial Research Laboratory at Needham, taking into consideration the mean latitudes of the spots in both hemispheres and the drift toward the solar equator in the course of a cycle, have led to a prediction of 1948.2.

It should be pointed out that since the discovery of the change in the polarity of the magnetic fields of sunspots in 1912 by Dr. George E. Hale and his associates, at the Mount Wilson Observatory, there is good reason for believing that the full sunspot cycle is of about 22 years' rather than 11 years' duration. A study of the past 70 years of sunspot cycles (Fig. 2) shows also the definite tendency for a change in pattern of the sunspot curve in alternate maxima. The sunspot maxima of 1870, 1893, 1917, and 1937 were all characterized by a sharp peak following a rapid rise. The maxima of 1883, 1907, 1928, on the contrary, show a rounded top with high sunspot numbers lingering for a year or two around maximum. If this is a present trend, then we should anticipate that the coming maximum may yield relatively high sunspot numbers throughout both the years 1947 and 1948, with the top of the

hump occurring in the early part of 1948. However, the sun appears to be full of surprises, and we shall know better whether this trend is to persist in the future after the next maximum is past.

There are, of course, wide fluctuations in the daily and monthly values, largely owing to the 27-day rotation period of the sun on its axis, bringing into view a given group of disturbances that may persist sometimes for weeks or months. For studying the long-term trend a 12- or 13-month moving average eliminates most of these day-by-day and month-by-month irregularities. However, for a study of correspondence with geomagnetic phenomena and especially radio communication conditions, shorter periods are of interest. In this case, quarterly averages or, better yet, 3-months' running means form a satisfactory curve for the study of secondary fluctuations of solar activity. From a recent study of such secondary fluctuations it would appear that we may expect another abrupt rise of solar outbursts in the latter part of 1946 or early 1947 while the main trend is still on the rise. An interval of from 12 to 15 months characterizes the space between these minor peaks, and this interval may in a large measure govern the success of any prediction for the actual maximum of the coming cycle, especially so far as fractions of a year in predicting are concerned.

The effect of sunspots upon the earth has long been an intriguing question. The oldest terrestrial concurrent phenomena have been those of the changes in the earth's magnetic field. These have been known to follow sunspots for over a century.

It was the advent of radio and the discovery of the ionized shell of the earth's atmosphere that made possible the explanation of the changes in geomagnetic phenomena with changes on the sun. When flares of ultraviolet light, or corpuscles, emitted from sunspot areas disturb the electron density in the upper air, there is a resultant electrical current aloft which induces a magnetic field on the earth that produces the well-known magnetic storms and compass variations accompanying sunspot phenomena. It is thus seen that the effect of sunspots on the earth is a direct one and that whatever other terrestrial effects may or may not be caused, electrical changes accompanying sunspots have been definitely traced in our atmosphere to within 70 miles of the earth's surface. The growth of trees in selected regions of the globe has also been found to show a fairly close correspondence with the sunspot cycle, presumably because of climactic changes, of which precipitation appears to be most important. There is also accumulating evidence that changes in solar radiation may have an effect upon short-time weather changes, but the problem is a complex one. Whether or not other terrestrial phenomena more or less periodical in character may be related to sunspots remains yet to be proved, and such questions must be regarded for the time being as lying in the field of speculation.

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BOOK REVIEWS

EARLY THEORIES OF MAGNETISM

Soul of Lodestone, The Background of Magnetical Science. Alfred Still. x + 233 pp. $2.50. Murray Hill Books, Inc. 1946.

THE author of this book is an electrical engineer long distinguished as a practitioner and as a teacher of his profession. Arrived at "the Indian summer of his days," he holds that "while the light endures it is good to look around and examine all things. . . . There is a primitive urge that bids us seek." He has looked back across the centuries and has reviewed all that men have thought and written and done about electricity and magnetism. And the world is richer by two books, *Soul of Amber* and *Soul of Lodestone.*

In these books the reader joins his master and guide for a journey through the ages. They walk and talk with the philosophers, live their lives, and share their thoughts. They look upon amber and lodestone as the philosophers saw them. And how rational the old views were, and how useful in their times! The reader grows as he journeys. He learns through the years to be ever critical of his thoughts.

Quotations from the books may suggest their flavor:

> The lodestone draws iron from a distance and has a secret understanding with the poles of the world. *Lodestone,* p. 192.

> A great deal has been published in many languages on the earlier theories of electricity. . . . If we consider these theories critically and without prejudice, they will begin to appear not unreasonable in view of the evidence upon which they were founded. *Amber,* p. 141.

> The latest theory is often the most pleasing and, as such, is helpful for the time being in stimulating the scientist to further efforts. But there is no finality. *Lodestone,* p. 200.

> What a good man bequeaths us of himself—of what he was apart from what he accomplished—may be of even greater value than his contributions to our knowledge of the physical world. (Michael Faraday). *Amber,* p. 241.

Soul of Lodestone guides its reader until the electron and the quantum appear and the atom discloses a structure. Then it guides no more. But the soul of lodestone marches on. Let the reader turn to *Science,* July 26, 1946, and consider Professor Barnett's account of the International Conference on Magnetism held at Strasbourg during May 1939. He may glean from it that philosophers are still abroad in many lands; and he may be led to read the address that closed the conference, "Magnetism in the Last Fifty Years," by E. Bauer.

As Professor Still taught it, electrical engineering must have been a cultural subject in the richest and fullest meanings of the phrase.

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YESTERDAY ALONG THE HOUSATONIC

The Housatonic: Puritan River. Chard Powers Smith. x + 532 pp. Illus. $3.00. Rinehart & Company, Inc. New York. 1946.

THIS book opens with a double-page map which is irresistible to the many devoted friends of the Housatonic Valley. The valley is about 115 miles long, but the meanderings of the river give it an entire length of about 165 miles between its beginning, northeast of Pittsfield, Mass., and its final flow into Long Island Sound near Bridgeport, Conn. The whole valley and mountain-shed area is dotted with names of places in which and from which important American historical characters originated, worked, and went out to the larger world. And the region still has no end of industries that are the present-day representatives of long lines of industries marking the stages of industrial evolution. In each area where there are no industries today, there are suggestive remnants: an iron

furnace, a charcoal pit, a granite or marble quarry. There are old apple orchards with native second-growth forest trees. Among them one may find cellars and tumbled wastes of once-fine residences, formerly occupied by large and industrious families, who no longer have living representatives in the mountains or valley. If one needs modern illustrations of the valley's industrial evolution, let him note the many fallen tobacco barns, vacated when the labor situation began to choke tobacco farming; or attempt to purchase maple sugar or sirup in regions now producing just enough to remind us of what used to be; or note the splendid dairy herds and poultry flocks from which much food is shipped to large city markets; or, even more significant, observe the extensive occupancy of both farm and wooded lands by more or less wealthy city people, few of whom are descendants of early natives. And the wealth and desire for ease of these "city slickers" has changed the whole economic setup and much of the social life once so characteristic of the industrial and rural civilization of the valley.

The river, which the Indians called Hous-aton′-uck ("Place-beyond-the-mountains," meaning Berkshires), also had other names for one or another part of its course. But the author coins the name "Puritan River," which name he proceeds to justify. First, he recounts the doings of several Indian tribes who claimed ownership of different parts of the entire area; an account of extreme interest. He characterizes these tribes as "Heathen of the Land." This prepares the way for accounts of subsequent numerous efforts of so-called religious groups who sought their own freedom while planning new settlements at points throughout the entire Housatonic area.

There follow chapters devoted to different regions of settlement: Stratford, Danbury, New Milford, Stockbridge, and Pittsfield, with references included to almost all towns and community centers of the entire area. The book includes dates and locations of first settlements, the people concerned, usually with their descendants down to modern times, and stories of the agricultural and other productive interests.

From early history the Housatonic area has been educationally inclined. Perhaps life was hard enough to emphasize the need of education. Anyway, fee schools flourished and drew support from outside as well as from the valley. In due time those schools declined, and public schools, caring for everybody's children, developed. Private college-preparatory and "finishing" schools then came and still feature the whole valley. Eminent scholars, scientists, professional men, and businessmen even made their homes in Pittsfield, Great Barrington, Canaan, and elsewhere. Great Barrington, Stockbridge, Lenox, and Pittsfield became desired summer regions for persons of great wealth. They paid fabulous prices for large areas, built absurdly large and ornate castles (cottages), imported foreign superintendents, gardeners, servants, and all that goes with them. Some of these estates have already reached the third-generation breakup. Most of the imported help has filtered into the industrial and social life of the region, even in some cases becoming owners of parts of the estates once operated by their wealthy and aristocratic employers.

The book is anecdotal, even gossipy at times, and so filled with local color that once started it is difficult to stop reading it. Its illustrations may be good art, but do not illustrate so well as would good photographs. The closing chapters discussing the meaning to America of the kind of life, agriculture, industry, and society which were characteristic of upper Housatonic estates are rather fundamental to modern interpretations

of democracy. Many quotations such as the following could be made showing the trials of aristocracy amidst democracy. Speaking of the two daughters of "one of the most refined cottagers," the author says:

> Because of a faint psychopathic taint in the young ladies' inheritance, psychiatrists advised the father to confine them from social contacts until they had passed a certain age. The prescription was enforced for several years. Then, on the same day, the unfortunately healthy American girls eloped respectively with the head chauffeur and the poulterer, the four of them going over the hill to Richmond where the Congregational minister tied the unfilial knots.

The closing chapter, Baedeker in a Canoe, describes an imaginary trip the length of the river with side trips to view today's life and industries; it makes one want to travel again over the entire valley. The whole book is a highly significant one on American history.

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CHILD PSYCHOLOGY

Manual of Child Psychology. Leonard Carmichael, Ed. viii + 1068 pp. Illus. $6.00. Chapman and Hall, Ltd. London. John Wiley and Sons. New York. 1946.

ASSUREDLY not a book to be damned with faint praise, Dr. Leonard Carmichael's new *Manual of Child Psychology* will be enthusiastically received by workers in the fields of pediatrics, child guidance, psychology, psychiatry, medicine, and education.

The scope of the manual, in Dr. Carmichael's own words, is that of "an advanced-level textbook designed to bridge the gap between elementary textbooks in this field and the scientific periodical literature of psychology." The material is presented as a series of separate chapters, each written by a recognized authority: Anderson, Cruikshank, Pratt, Thompson, Gesell, McGraw, Goodenough, McCarthy, Harold E. Jones, Dennis, Mead, Vernon Jones, Jersild, Lewin, Doll, Miles, Terman, and Carmichael himself. The purpose of the manual is "to provide an accurate and coherent picture of some of the more important aspects of research in the scientific psychology of human development," and it demonstrates clearly that in child psychology "the speculative period is definitely past."

In Dr. Anderson's chapter, Methods of Child Psychology, attention is directed to changes in the concept of the nature of the child, types of problems dealt with in child psychology, central problems of method in attacking specific problems in the field, sources of material for child study, techniques for securing data, the development of measuring instruments and the determination of their precision, sampling, the organization and design of studies, variations of techniques with age, and finally the evaluation of a study. This last section of Anderson's on evaluation of studies and checking on planned researches has value not only for scientists in psychology but also for those in many other fields. To this reader, the two columns of questions used to analyze studies constitute some of the most valuable material in the compendium; if used carefully by all workers in the field, they would be instrumental in eliminating some of the journal literature of dubious merit.

In dealing with the problem, "What is the origin and what is the embryology of the behavior patterns which are significant in an understanding of human mental life?" Carmichael treats the development of behavior in the lower vertebrates (with critical appraisal of the work of Preyer, and of Coghill on *Amblystoma*); the development of behavior in the embryos of birds (citing the work of Kuo on chick embryos); the development of prenatal behavior in the infrahuman mammal; certain general aspects of human fetal development;

nonoperative studies of behavioral development in the human fetus; the study of behavior in operatively removed human fetuses; the special senses in human prenatal life; and the senses in general relationship to the onset of mental life in the prenatal period.

I mention the order in which these topics are discussed to indicate the logical presentation of material in these two chapters. The remaining seventeen chapters are presented no less effectively by their several authors.

Equipped with the material in Carmichael's chapter, the advanced student is then properly prepared to go on into the next five sections of the manual: Animal Infancy, by Cruikshank; the Neonate, by Pratt; Physical Growth, by Helen Thompson; the Ontogenesis of Infant Behavior, by Gesell; and Maturation of Behavior, by McGraw. The figures, photographs, tables, charts, and graphs in these chapters are particularly good.

Perhaps one of the most fascinating sections of the manual is that by Margaret Mead, Research on Primitive Children, which includes forty photographs of various forms of child behavior among the Iatmul, Balinese, Pilaga, Pitjentara, and other primitive peoples. Mead's field notes provide entertainment as well as instruction; her comments on the need for future research among children in the few surviving primitive societies are well taken. Mead points out that once these societies have yielded to culture contact, we shall have no possible way of replacing them.

Doll's chapter on The Feeble-Minded Child is interestingly supplemented with over forty photographs, depicting clinical types of mental deficiency, grades (degrees) of mental deficiency, institutional training of feeble-minded children, occupational training of high-grade mental defectives, and cerebral anomalies in mental deficiency. Indeed, one of the most praiseworthy features of the entire manual is the liberal use of photographs, diagrams, charts, figures, etc., throughout.

In presenting so many and so varied a collection of points of view in the special fields of research in child psychology, Dr. Carmichael has accomplished an excellent piece of work. His manual is valuable for many features, not least of which are the splendid bibliographies found at the end of each chapter and the carefully prepared index. Graduate students and specialists in related fields will appreciate these fully as much as the wealth of information in the compendium itself. The proofreading must have been a genuine labor of love, for I met with no typographical errors whatever in the manual. All those associated with Dr. Carmichael in compiling the manual deserve individual congratulations on their efforts and highly successful attainments.

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AGASSIZ THE TEACHER

Louis Agassiz as a Teacher. Lane Cooper. 90 pp. Portrait. $1.50. Comstock Publishing Co., Ithaca, N. Y. 1945.

IN THIS volume, a revision and amplification of an edition published in 1917, Professor Cooper has brought together various extracts illustrating the method of pedagogy so successfully practiced by [Jean] Louis [Rodolphe] Agassiz, the Swiss-born naturalist who distinguished himself in America lecturing and teaching zoology at Harvard College. Scarcely a man is now alive who personally remembers him, but there has grown up around his name an aura of legend, anecdote, and glory that will last, we hope, forever. (Breathes there the man who has not read that classic essay of Dallas Lore Sharp, "Turtle Eggs for

Agassiz''?) Agassiz belonged, indeed, in a great triumvirate of American naturalists—John James Audubon, the artist; Henry David Thoreau, the philosopher; and Louis Agassiz, the teacher-scientist. Any book about him is important to American science, as any book about Lincoln is to American history.

The volume leads off, following an introductory note by Professor Cooper, with a brief account of Agassiz at Neuchâtel reprinted from Mrs. Agassiz's *Louis Agassiz, His Life and Correspondence* (1885) and A Sketch of the Life and Work of Agassiz, an essay by Helen Ann Warren (Mrs. Malcolm D. Brown) that first appeared in THE SCIENTIFIC MONTHLY (1928) and was later (1934) revised for *The American Scholar*. Then comes another excerpt from Mrs. Agassiz's *Life* on Agassiz at Harvard, followed by four firsthand testimonials: How Agassiz Taught Professor Shaler, from *The Autobiography of Nathaniel Southgate Shaler* (1907); How Agassiz Taught Professor Verrill, from a private letter from A. E. Verrill to Lane Cooper; How Agassiz Taught Professor Wilder, from an article by Burt G. Wilder in the *Harvard Graduates' Magazine* (1907); and How Agassiz Taught Professor Scudder, from a paper by Samuel H. Scudder dating from 1874 in *Every Saturday*. The remaining four chapters consist of a woefully incomplete list of Agassiz's pupils, from the SCIENTIFIC MONTHLY article cited above; an essay on Agassiz's personality and on his death, by Lane Cooper; a few pages of Obiter Dicta by Agassiz himself apropos of his pedagogy; and finally two passages for comparison with the method of Agassiz, one from the *Encyklopädie und Methodologie der philologischen Wissenschaften* of August Böckh, German classical scholar and a near contemporary of Agassiz, on the study of history and literature, and one from Plato's *Symposium*.

Just what was Agassiz's philosophy of teaching? Perhaps it is best described in the words of Böckh:

> Everything in science is related; although science itself is endless, yet the whole system is pervaded with sympathies and correspondences. Let the student place himself where he will—so long as he selects something significant and worth while—and he will be compelled to broaden out from this point of departure in order to reach a complete understanding of his subject. From each and every detail one is driven to consider the whole; the only thing that matters is that one go to work in the right way, with strength, intelligence, and avidity. Let one choose several different points of departure, working through from each of them to the whole, and one will grasp the whole all the more surely, and comprehend the wealth of detail all the more fully. Accordingly, by sinking deep into the particular, one most easily avoids the danger of becoming narrow.

So it was that Agassiz would place a fish, a clam, or what not before the student and expect him, without the aid of dissecting knife or microscope, by sheer objective observation and a persevering intelligence, to drain the cup of knowledge dry so far as the specimen before him was concerned. If the method seems to us a bit cruel, we must remember that with it all went the teacher's compelling and lovable personality and his vitality. As Professor Wilder says:

> The secret of his greatest power was to be found in the sympathetic, human side of his character. Out of his broad humanity grew the genial personal influence by which he awakened the enthusiasm of his audiences for unwonted themes, inspired his students to disinterested services like his own, delighted children in the school-room, and won the cordial interest, as well as the co-operation in the higher aims of science, of all classes, whether rich or poor.

It is good to have this devoted little anthology testifying to Louis Agassiz's greatness. When he was once asked, "What do you regard as your greatest work?" he replied, "I have taught men to observe." Perhaps even twentieth-century pedagogues, who seem at the moment to be needing a few ideas where-

with to meet the challenge of the New Age in education, might still take a tip from Louis Agassiz's fish. His methods, to be sure, were not new with him, but he made them work, and students came away from his instruction inspired and equipped to meet the world. And—

Forever seeking truth, not vain acclaims,
He kindled, on the way, a thousand other flames.

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GODDARD'S ROCKETS

Rockets. Robert H. Goddard. xix + 79 pp. $3.50. American Rocket Society. New York. 1946.

THIS book is a reprint of Dr. Goddard's famous reports to the Smithsonian Institution. The originals are out of print. The foreword to this edition was written by Dr. Goddard on May 1, 1945, shortly before his death on Aug. 10, 1945.

It is generally recognized that Goddard laid the foundation of modern jet and rocket propulsion in his two articles published in the *Smithsonian Miscellaneous Collection* and reproduced by facsimile printing for the American Rocket Society. The first article, "A Method of Reaching Extreme Altitudes," appeared in 1919 (69 pp., 10 plates). There is given in detail work performed at Clark University on powder rockets. The fundamental engineering data on nozzle design, jet velocity, propulsion *in vacuo*, etc., are developed to the experimental stage. Calculations and experimental data are included on the size of a flash powder charge on the moon visible from the earth. A very important series of data prove that rockets should take off at a high altitude for maximum performance. This point has not been adequately utilized by our rocket proving fields today. The effect of air pressure is astounding. For example, at 15,000 feet altitude only about half the fuel charge is required to reach the same height as from a start at sea level. The importance of high-velocity gas streams is described. The efficiencies of various rockets are reported from experimental tests. Work on the use and recovery of testing apparatus to be installed in a rocket is included. The mass of scientific and engineering data included in the article is well worth the price of the book to a rocket investigator.

The second article, "Liquid-Propellant Rocket Development," was published in 1936 (10 pp., 11 plates). This was a preliminary report to the Guggenheim Foundation, which had supported Goddard's rocket research at Roswell, N. M. The data on liquid-fueled rockets in this report have been verified in a rather dramatic fashion by the Nazi V–2 and Me–163 high-altitude rockets and rocket planes in the recent war. It is interesting to note the discussion of the gyroscopic stabilizers by Goddard in the light of their development today for the same purpose.

The plates for both articles are a part of the archives of rocket development and date the work very effectively.

G. Edward Pendray, Secretary and one of the directors of the American Rocket Society, wrote a biographical appreciation of Dr. Goddard for the book.

The make-up of the book was well conceived, and it should be on every rocket experimenter and enthusiast's bookshelf.

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COMMENTS AND CRITICISMS

The Criteria of Patentability

The timely article "Criteria of Patentability" by Major J. H. Byers appearing in THE SCIENTIFIC MONTHLY, May 1946, contains the following very appropriate statement: "There really ought to be attached to each and every patent that issues from the Patent Office the following warning: 'Inventor beware! This patent is only a license to sue. . . . What the Court will do to it is beyond prediction.'"

The importance of Major Byers' statement will, no doubt, be more fully realized if a few additional remarks on patent litigation are made, showing for instance how very true Judge Learned Hand's testimony before the Committee on Patents, House of Representatives, in 1919 was when he made the statement that "some of them [Judges] have a constitutional inability to understand complicated questions of machinery, and we all have a very great inability to understand the more difficult questions such as come up in electrical and chemical patents. I think I can safely say that all of us, when we get a really stiff patent, involving electrical current and questions of chemistry, are helpless" (P. 150. Hearings before the Committee on Patents, U. S. Senate, Seventy-fifth Congress).

Questions regarding sufficiency of disclosure, prior disclosure, sufficiency of claims, and infringement primarily involve technical questions. How then can Federal Judges who are admittedly helpless in such matters be relied upon to properly adjudicate a patent, and why does Congress permit such a condition to exist? It is true that the late Senator McAdoo in 1937 introduced a bill regarding a Court of Patent Appeals providing scientific advisers, and hearings were held, but nothing came of it.

I illustrated these undesirable conditions in great detail to the Temporary National Economic Committee in 1939, as the result of an infringement case in which I testified in 1937 before the U. S. District Court, Southern District of New York.

The patent in question, a basic Method Patent on Mercury Arc Rectifiers, based on acknowledged original research, was willfully infringed by a corporation. Basic claims were allowed by the Examiners-in-Chief of the U. S. Patent Office, and equivalent patents were granted by the Patent Offices in five predominant countries. I testified and proved that the method discovered in 1912 was not only overlooked by such inventors as Cooper Hewitt and his co-workers, Steinmetz and his co-workers, and all other authorities, domestic and foreign, but it was not until 1926 that the manufacturers were aware that this basic principle, now universally used, is essential for most efficient operation of large capacity Mercury Arc Rectifiers. So thorough was the testimony that the defense was unable to bring out a single publication, domestic or foreign, showing anticipation, although defendant's counsel, by distorting the quotations from patents and publications of the prior art and giving to them a meaning not intended or contemplated by the authors, endeavored to create the inference that there was knowledge of plaintiff's discovery prior to his disclosure.

However, defendant's patent attorney and "expert" succeeded in deceiving the Court by distorting the content of an article which, incidentally, had been carefully considered by the Examiners-in-Chief. Defendant's expert testified falsely in regard to the content of mentioned article after I had fully explained to the Court how defendant's patent attorney had distorted the meaning of the article.

The District Court held that there was no infringement, although the evidence conclusively showed there was infringement beyond a doubt. Since the District Court erred in twenty points, the case was brought before the Circuit Court of Appeals, Second Circuit.

Although the article in question taught just the opposite of what is disclosed in the infringed Method Patent and clearly brought out at the trial and in our briefs, yet the Circuit Court of Appeals erroneously claimed it to be an anticipation and thereby saved itself the trouble of considering the infringement question.

Counsel for plaintiff, after studying the situation, came to the following conclusion:

> The U. S. Supreme Court would have jurisdiction of the case, but applications for certeriorari are not freely granted and must be based on certain particular grounds, especially on questions of Law. Whether the Court would regard the case as depending on a question of Law would be doubtful, as all procedural matters were properly handled in the Patent Office as well as in the Courts. The question of novelty or prior disclosure would probably be regarded as a question of fact, or science, which the Supreme Court might not deem itself called upon to review.
>
> However, as to the validity of the Method Patent, there is no dispute as to the facts, no question of conflict in the evidence, so that the answer depends upon the interpretation of the facts. This could be regarded as a question of Law. How the Supreme Court would regard it cannot be foretold.

This revealed an amazing situation. Although the decisions by both Courts were contrary to what the statement of evidence very clearly revealed and, therefore, erred, yet there apparently existed no good reason for approaching the U. S. Supreme Court; although constitutional rights were transgressed to the nth degree, yet "the Supreme Court might not deem itself called upon to review."—WILLIAM TSCHUDY.

Principles and Problems of Public Medical Care

It is always the privilege and critical right of the reviewer to disagree with the point of view and basic philosophy of both book and author. However, when the reviewer of a serious book rejects both the point of view and the philosophy expressed and states dogmatically, "Its basic philosophy will not appeal to scientists," and bases his own rejection on anything but scientific grounds, it warrants a protest.

We have reference to Edward J. Stieglitz' review of Franz Goldmann's book *Public Medical Care* in the May issue. Stieglitz' emotional approach to the problem of public medical care is too palpably evident—to say nothing of his unscientific and loose usages of terminology in discussing problems raised in the book. He states: "The book is written from the point of view of a social worker primarily concerned with institutions, not from the viewpoint of the physician concerned with individuals." Why Dr. Goldmann's association with the Yale School of Medicine as Associate Professor of Public Health should disqualify him from having the physician's point of view is hard to understand.

The reviewer may disagree with Dr. Goldmann's medical-sociological point of view, but let us be spared the loose thinking, the repetition of clichés which are vague in content and meaningless on analysis. After the above-cited quotation the reviewer continues, "It is notably lacking in appreciation of the truly American tradition of individual initiative." Let us take a closer look at this thing called "individual initiative" (which appears to be another variation of "rugged individualism"). While this tradition had its roots in the historic and economic development of our country, today this concept is no longer valid. Today there are no new land frontiers to flee to, and the importance of the entrepreneur has all but disappeared in this period of monopoly capitalism. As a social concept today this idea is anachronistic in our complex society, with its enormous social interdependence for sheer survival, not only of the individual but of whole nations. To lend oneself to the perpetuation of such an outmoded social concept doesn't appear to indicate a high degree of scientific awareness of the changing social scene.

The reviewer further states there are many advocates of the idea, in addition to Dr. Goldmann, "that medical care is a government function." Does the reviewer mean those who are interested in government sponsorship of a national health program? It appears so; then he proceeds to break them down into three general groups. This breakdown is a narrow, prejudiced, and unscientific piece of analysis.

In group (1) the reviewer apparently includes the thousands of physicians in the country who are aware that the problem of health is the problem of the entire nation and not merely that of the individual who can afford to pay for medical care. He lumps in the same category the millions of trade unionists and their families, the white-collar and professional workers who have indicated their interest in proposed federal health legislation to protect themselves against economically calamitous illness by their representatives appearing at congressional hearings on such legislation during the past 8 years.

The legislators come in for their unscientific mauling in group (2). Nothing like dubbing them "politicians," with the word's connotation for venality, for setting the scene. It is ironic that the reviewer will single out for attack those few elected representatives who assume their political duties with integrity; and worse, in order to belabor his point, indulges in deliberate distortion when he says these "politicians" offer "something for nothing." This appears to be a veiled reference to National Health Bill S. 1606, sponsored by Senators Wagner and Murray and Representative Dingell, which is under fire from those in the medical profession who would in vain attempt to impede social progress. Proposals for financing this plan for national health insurance include *prepayments* by all employed, deductible from pay rolls, with a like percentage contributed by the employer. Provisions are also proposed for prepayment by individually employed, etc. Prepayments are to be made, that is, by those who will eventually benefit from the provisions of the bill; this is not "something for nothing," as the reviewer would have those believe who are unfamiliar with the pending legislation for a government-sponsored national health program.

Group (3) are the "idealistic dreamers." Is this a *precise* definition to describe those who believe democracy can be made to function? A very descriptive label to tack on those who believe that a government such as ours, which imposes enormous responsibilities on the individual and exists to carry out the mandates of its people through their legally elected representa-

tives, would not cease to fulfill this function if it assumed the responsibility for the general well-being of its people through the sponsorship of national, prepaid, health insurance measures. "Idealistic dreamers" in the opinion of the reviewer are all those who believe and support the postulate in Sec. 8, Art. 1 of the Constitution of the United States. The responsibility for the good functioning of the government devolves on every individual in our society. The good functioning of any government-sponsored national health program would involve the utmost cooperation of every individual with the doctors and the cooperative efforts of all to maintain the highest standards of health in the community.

Reviewer tosses in for good measure the tag "socialistic medicine." The die-hard opponents of National Health Bill S. 1606 (still in committee) have used this label cunningly and with deliberate design to confuse. What does this tag really mean? *What is* "socialistic medicine"? Is it pooling the resources of all medical science in the interests of the entire population? A broad concerted effort to extend the benefits of medical science to the whole of society? And if *this* is meant by "socialistic medicine," what is wrong with the idea? And if not, just *what* did the reviewer have in mind? Obviously, the word "socialistic" was intended to evoke distaste and antagonism. This word is bandied around so loosely, so inaccurately applied to any seemingly progressive measure, that the common connotation and interpretation are a far cry from the real meaning of the word. We feel it safe to make the general observation that to the majority of the people in the U. S. the word has a sinister meaning, and today, if you would discredit *any social idea* and confuse the issue, merely apply the word "socialistic" and the task is done.

Reviewer quotes from Dr. Goldmann's book, "Adequate medical care is a fundamental human right," and questions the value of the premise on the grounds of dogmatism; he then confounds the issue by offering a dogmatic statement of his own: "Health is a privilege and not a right." This is questionable logic and certainly questionable social thinking. Ethically and legally, it is accepted that "life, liberty, and the pursuit of happiness are the natural and inalienable *rights* of man." The dictionary defines "privilege" as "always special, exceptional and artificial. . . . something peculiar to one or some as distinguished from others." Reviewer fails to make clear who grants this privilege and indulges in rather cloudy thinking on the *right*-versus-*privilege* concept of the safeguarding of public health. (Just *what* does "sensible care" really mean?) Obviously, no plan so broad in scope as the proposed national health insurance plan can optimally function without the cooperation of every adult in society, based on individual responsibility. However, it cannot be deduced that such cooperation will not be forthcoming merely because such a health program is government-sponsored. The health and well-being of society is the responsibility of society individually and collectively. Our democratic government is charged in our Constitution with the fundamental duty to provide for the "general welfare." The reviewer apparently questions whether public health comes under the heading of general welfare. Without healthy bodies there can be no talk of well-being, no basis for education, for social progress and development.

The reviewer's approach to analysis of books in the field of medical sociology is anything but a scientific, rational one. Such a review as his has no place in a publication with the aims of THE SCIENTIFIC MONTHLY. There is too much confusion spread by the loose and casual usage of the English language, by the emotional consideration of vital social problems, in the daily press and periodicals of general interest. If the safeguarding of our civil liberties requires eternal vigilance, surely this same type of vigilance should be exercised in the field of science to nurture and develop the scientific point of view in the consideration of social problems.—GERTRUDE HUTCHINSON.

Our Everyday Reckonings

Mr. George Colles attempts to make a strong case against adoption of the metric system, but he has failed to move me, at least. In the first place, he does not even claim that our present system is superior to the metric system. Furthermore, he does not consider the changes that have occurred in the world during all the years since Secretary Adams first advocated the metric system. During that period physical integration has vastly outdistanced social integration. There is now a distinct division between the English-speaking nations, which do not use the metric system, and the non-English-speaking nations, which do. If we can use compulsory adoption of the metric system as a lever to induce non-English-speaking countries to adopt English (the principal language of business and science) as a secondary language, taught in all schools, a great step toward reducing this appalling lack of social integration will have been accomplished. It is interesting to note that the United States was the first country to adopt the decimal system of coinage (in the time of Adams) and that since then every country in the world has adopted it (except Great Britain, naturally).—EDWIN DURST.

THE BROWNSTONE TOWER

As predicted in the October issue, we have moved from the Brownstone Tower to our new quarters on Scott Circle at 1515 Massachusetts Avenue, Washington 5, D. C. But because we are celebrating in this issue the centennial of the founding of the Smithsonian Institution, the Brownstone Tower is not absent from it. We have placed on the cover a photograph of the Smithsonian in which the Tower and our late, beloved office behind the clock face are conspicuous. The Owl Tower is partly hidden by the tree on the right. We do not know the date of this picture, but, judging from the appearance of the cars parked at the right, we believe it must have been taken around 1930 before the Mall was made a thoroughfare and parking lot. The statue of Joseph Henry, first Secretary of the Smithsonian, now stands before the main entrance of the building as shown on page 371, and the landscaping and roads in front of the building have been greatly changed. But the building itself looks as it did during the Civil War.

We have not attempted in this issue to give a comprehensive account of "The First Hundred Years of the Smithsonian Institution." That has been done by Webster P. True, Chief of the Editorial Division of the Institution, in a beautifully illustrated booklet of 64 pages bearing the title just quoted. We offer merely a miscellaneous collection of papers by eleven members of the Smithsonian staff representing six Divisions of the United States National Museum, the Freer Gallery of Art, the National Zoological Park, the Astrophysical Observatory and its Division of Radiation and Organisms, and the Editorial Division of the Institution. Although our coverage of the activities of the Smithsonian is by no means complete, we have tried by selection of subjects in the manuscripts solicited to impress upon our readers the wide range of interests of the Smithsonian.

Only one principal article, that by Bart J. Bok, Harvard College Observatory, did not originate in the Smithsonian. His article on "Science in UNESCO" is included because it is important and timely and deals appropriately with the beginning of what may become an international extension of the aims of James Smithson.

We wish to call attention particularly to the poem on James Smithson (pp. 348 and 349) by Paul H. Oehser, Assistant Editor of the Institution. We urge those who customarily skip the poetry we publish to read "James Smithson." Here in stirring words are the aspirations of a man whose name shall never die as long as science lives.

In our hail and farewell to the Smithsonian we want to thank Dr. Alexander Wetmore, Secretary, and Mr. John E. Graf, Assistant Secretary, for their support of this issue and for their unfailing courtesies during our stay in the Brownstone Tower. To the fifth Secretary of the Institution, Dr. C. G. Abbot, our recent neighbor in the Tower, special thanks are due for providing on short notice the words of wisdom on pages 325 and 326. By personal example of unremitting and enthusiastic work in his office in the top of the Tower, Dr. Abbot demonstrates the highest devotion to the ideals of James Smithson. Our gratitude extends to all other contributors to this issue who during the heat of the summer succeeded in preparing their manuscripts for publication. To all who have helped us in the Smithsonian at other times and in other ways we say goodbye with regret. During the years to come may the Smithsonian and the A.A.A.S. continue to promote still more effectively "the increase and diffusion of knowledge among men."

F. L. CAMPBELL